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Optimizing active guard reserve enlisted manpower

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THESIS

OPTIMIZING ACTIVE GUARD RESERVE ENLISTED MANPOWER

by

Alan K. Schrews

June 2002

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The principal mission of the United States Army Reserve (USAR) is to maintain properly trained and equipped units available to promptly mobilize for war, national emergency, or other contingency operations, and to assist the Army in projecting land combat power. The Active Guard Reserve (AGR) program provides active duty reserve soldiers (officer and enlisted) to Army Reserve units and Regular Army units to support reserve missions. The proper placement and manning of the AGR force is critical to the readiness of the Army Reserve and to the strength of the Total Army.

To assist the efforts of the Office of the Chief, Army Reserve, Program Analysis and Evaluation division (OCAR-PAE) to analyze the AGR enlisted force, this thesis develops an optimization model known as the AGR Enlisted Manpower Projection Model (AGR-EMPM). The primary purpose of the model is to serve as a manpower forecasting and decision analysis tool. The model aggregates at the career management field level by rank, active federal service, and time in grade. With a 7-year planning horizon, the model is ideally suited for near term policy analysis. To demonstrate the usefulness of the model, scenarios relating to stop loss and accessions are analyzed.

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OPTIMIZING ACTIVE GUARD RESERVE ENLISTED MANPOWER

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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

The principal mission of the United States Army Reserve (USAR) is to maintain properly trained and equipped units available to promptly mobilize for war, national emergency, or other contingency operations, and to assist the Army in projecting land combat power. The Active Guard Reserve (AGR) program provides active duty reserve soldiers (officer and enlisted) to Army Reserve units and Regular Army units to support reserve missions. The proper placement and manning of the AGR force is critical to the readiness of the Army Reserve and to the strength of the Total Army.

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The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

The reader is cautioned that computer programs developed in this research may not have been exercised for all cases of interest. While every effort has been made, within the time available, to ensure that programs are free of computational and logic errors, they cannot be considered validated. Any application of these programs without additional verification is at the risk of the user.

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LIST OF ACRONYMS

AC	Active Component
AFS	Active Federal Service
AGR	Active Guard and Reserve
AGRET	Active Guard Reserve Entrance Training
AGRMIS	Active Guard Reserve Management Information System
AOC	Area of Concentration
AR	Army Regulation
ARNG	Army National Guard
AR-PERSCOM	Army Reserve Personnel Command
ASA (M&RA)	Assistant Secretary of the Army for Manpower and Reserve Affairs
CAR	Chief, Army Reserve
CMF	Career Management Field
CPL	Corporal (Pay Grade E-4)
DA	Department of the Army
DCSPER	Deputy Chief of Staff for Personnel
EMPM	Enlisted Manpower Projection Model
FORSCOM	United States Army Forces Command
FTS	Full Time Support
FTSMD	Full Time Support Management Directorate
FY	Fiscal Year
GAMS	General Algebraic Modeling System
IMA	Individual Mobilization Augmentee
IRR	Individual Ready Reserve
MOS	Military Occupational Specialty
MSG	Master Sergeant (Pay Grade E-8)
OASD (RA)	Office of the Assistant Secretary of Defense, Reserve Affairs
OCAR	Office of the Chief, Army Reserve
OCAR-PAE	Office of the Chief, Army Reserve, Program Analysis and Evaluation
OCAR-RTD	Office of the Chief, Army Reserve, Retention and Transition Division
PAM	Pamphlet
PML	Programmed or Managed Loss
PFC	Private First Class (Pay Grade E-3)
PVT	Private (Pay Grade E-1)
PV2	Private (Pay Grade E-2)
PZ	Primary Zone
RA	Regular Army
RC	Reserve Component
RCP	Retention Control Point

RFPB	Reserve Forces Policy Board
SFC	Sergeant First Class (Pay Grade E-7)
SGM	Sergeant Major (Pay Grade E-9)
SGT	Sergeant (Pay Grade E-5)
SL1	Skill Level One
SPC	Specialist (Pay Grade E-4)
SSG	Staff Sergeant (Pay Grade E-6)
SZ	Secondary Zone
TIG	Time in Grade
TIS	Time in Service
TPU	Troop Program Unit
USAR	United States Army Reserve

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EXECUTIVE SUMMARY

The principal mission of the United States Army Reserve (USAR) is to maintain properly trained and equipped units available to promptly mobilize for war, national emergency, or other contingency operations, and to assist the Army in projecting land combat power. Today's Army Reserve is considered not only an auxiliary force, but also a well-organized and efficient depository of highly trained and skilled soldiers ready to augment the regular force on short notice.

The Active Guard Reserve (AGR) program provides active duty reserve soldiers (officer and enlisted) to Army Reserve units and Regular Army units to support reserve missions. These soldiers function in leadership positions and as support staff at each level of command. A very large proportion of the Reserve Personnel, Army (RPA) appropriation addresses the requirements of the AGR force. The proper placement and manning of the AGR force is critical to the readiness of the Army Reserve and to the strength of the Total Army.

The composition of the AGR program at the end of FY 2001 was approximately 72.4% enlisted and 27.6% officer (including warrant officers). Even though the enlisted force comprises the largest manpower category, few tools exist at the Army Reserve Personnel Command (AR-PERSCOM) in St. Louis, MO or the Program Analysis and Evaluation (OCAR-PAE) division of the Office of the Chief, Army Reserve in Washington, DC to analyze enlisted manpower problems.

This thesis addresses management of the AGR enlisted force through optimization. The optimization model, developed as a basis for this thesis, addresses enlisted manpower optimization at the rank, career management field (CMF), active federal service (AFS), and time in grade (TIG) level of detail. With a 7 year planning horizon, the model is ideally suited for near term policy analysis.

To demonstrate the usefulness of the model, three scenarios are analyzed. The first two scenarios analyzed implementation of stop loss on various CMFs. The term "stop loss" refers to stopping the loss of critical skills from the enlisted inventory. The

results of the analysis suggest that implementing a stop loss for either a long or short duration reduces promotion rates and the demand for accessions. The decreasing accessions may be good, however, a reduction in promotion rates may reduce morale. Should a stop loss be directed by HQDA, I recommend that intensive analysis be conducted to determine the global effects to inventory, accessions, and promotions within each rank and CMF before implementation.

The third scenario analyzed the Chief, Army Reserve's recent decision to access Master Sergeants into the AGR program. The results of the analysis suggest that the accession of MSGs into the AGR program has the potential for serious long-term effects on promotion rates. The most heavily affected were promotion rates to MSG (-40.44%) and to SGM (-25.41%). While average enlisted inventory and accessions increased, the promotion rates for every rank decreased. This outcome suggests that great care must be taken not to over access Master Sergeants into the inventory and thereby seriously reduce long-term promotion rates.

I. INTRODUCTION

The Active Guard Reserve (AGR) program provides active duty reserve soldiers (officer and enlisted) to Army Reserve units and Regular Army units to support reserve missions. These soldiers function in leadership positions and as support staff at each level of command. A very large proportion of the Reserve Personnel, Army (RPA) appropriation addresses the requirements of the AGR force. The proper placement and manning of the AGR force is critical to the readiness of the Army Reserve and to the strength of the Total Army.

A. PROBLEM STATEMENT

The composition of the AGR program at the end of FY 2001 was approximately 72.4% enlisted and 27.6% officer (including warrant officers). Even though the enlisted force comprises the largest manpower category, few tools exist at the Army Reserve Personnel Command (AR-PERSCOM) or the Office of the Chief, Army Reserve, Program Analysis and Evaluation (OCAR-PAE) section to analyze enlisted manpower problems. This thesis addresses the problem of making AGR enlisted manpower projections in a dynamic environment where entry into the system is possible at most any rank. Based on the necessary target strength at different time periods, decisions must be made on the number of accessions, reclassifications, forced separations, and promotions within each military occupational specialty (MOS)/career management field (CMF) within the AGR enlisted force. The purpose of this thesis is to develop a mathematical model for OCAR-PAE that will provide insight into the AGR enlisted manpower system, assist in managerial decisions, and improve analysis of the enlisted AGR force. This model will recommend management decisions and allow analysts to assess the impacts of personnel and command policies. The optimization model developed in this thesis is implemented in the General Algebraic Modeling System (GAMS).

B. MOTIVATION FOR BUILDING AN ANALYSIS TOOL

The use of the model will provide insight into the following issues:

- Determining accession policy by year by CMF to meet yearly CMF target strength and yearly target end strengths.

- Identifying over-strength and under-strength CMFs based on reclassification flow.
- Planning of training seats in Active Guard Reserve Entrance Training (AGRET) based on yearly accession flow.
- Forecasting of enlisted inventory to assist in budgetary planning.
- Assessing the effects of policy changes such as adjustments to promotion zones, changes to retention control points (RCP), stop loss from certain CMFs, and limits on forced separation.

C. THESIS OUTLINE

Chapter II provides background on the Army Reserve. Chapter III provides an overview of Full-Time Support and the AGR Program. Chapter IV gives a detailed look at AGR Enlisted Management. Chapter V introduces the AGR Enlisted Manpower Projection Model (EMPM) and provides a partial literature review of operations research models applied to military personnel planning. In conclusion, Chapter VI analyzes the results of the model and Chapter VII provides conclusions, recommendations, and areas for future research.

II. BACKGROUND

A. ARMY RESERVE MISSION

The principal mission of the United States Army Reserve (USAR) is to maintain properly trained and equipped units available for prompt mobilization for war, national emergency, or other contingency operations, and to assist the Army in projecting land combat power. Today's Army Reserve is considered not only an auxiliary force, but a well organized and efficient depository of highly trained and skilled soldiers ready to augment the regular force on short notice. The Army Reserve is the most employed Reserve Component across the entire spectrum of operations. Few U.S. Army military operations today would succeed without the support and participation of the Army Reserve or other Reserve components. (Reserve Forces Policy Board, 2001)

B. ARMY RESERVE STRENGTH AND COMPOSITION

A reduction in the size of the Regular Army has forced a majority of the sustaining operations to be conducted by the Reserve Components. Based on data obtained from the DCSPER-46 Report (Strength of the Army, Part III Strength, Reserve Components, USAR, as of 30 September 2001), Table 1 shows the composition of the Army Reserve at the end of FY 01.

Ready Reserve	357,373
Standby Reserve	753
Retired Reserve	779,017
Total U.S. Army Reserve	***1,137,143***

Table 2.1 Composition of USAR at the end of FY 2001 (From: DCSPER-46, 30 Sep 01)

The Ready and Standby Reserves comprise approximately 20% of the total Army and contain a majority of the Army's combat service support forces. (U.S. Army, 1999a)

C. RESERVE CATEGORIES

Each member of the Army Reserve can be categorized as a member of one of the following: Ready Reserve, Standby Reserve, or Retired Reserve. Army Reservists belong to the Ready Reserve if they are members of military units or are individuals subject to recall to active duty to augment the Regular Army in time of war or national emergency. The Ready Reserve has two subcategories to which an Army Reservist may belong: Selected Reserve or Individual Ready Reserve (IRR). Army Reservists in the Selected Reserve subcategory of the Ready Reserve are Army Reserve drilling unit members, Active Guard Reserve (AGR) soldiers, and Individual Mobilization Augmentees (IMA). (Office of the Assistant Secretary of Defense (Reserve Affairs), 2000)

The Individual Ready Reserve consists of previously trained personnel assigned to a control group for administration purposes who are available for mobilization in time of war or national emergency. The "Annual Training" control group consists of personnel with a training obligation. The "Reinforcement" control group consists of personnel with obligated service but with no training requirement and those personnel without obligation who participate in non-unit programs for retirement points. (Office of the Assistant Secretary of Defense (Reserve Affairs), 2000)

Table 2 shows the composition of the sub-categories of the Ready Reserve as of 30 September 2001 as follows:

Selected Reserve	205,628
Troop Program Units	*187,409*
Active Guard/Reserve	*13,106*
Individual Mobilization Augmentee	*5,113*
Individual Ready Reserve	151,745
Total Ready Reserve	***357,373***

Table 2.2 Composition of the Ready Reserve at the end of FY 2001 (From: DCSPER-46, 30 Sep 01)

Generally, most soldiers in the Standby Reserve have completed all active and reserve training requirements. Those soldiers in the Standby Reserve with a military service obligation will be reassigned to the Ready Reserve at the earliest opportunity. Assignment to the Standby Reserve can be made by request if the soldier is in a sensitive civilian position with the government. Key government employees, such as members of

Congress or of the Judicial System, are prime candidates for assignment to the Standby Reserve. (U.S. Army, 1994b)

Soldiers in the Retired Reserve are either eligible for retired pay from military service or are currently ineligible for retired pay but have twenty or more years of qualifying service in the Army, Army Reserve, or the Army National Guard (ARNG). In times of national emergency, certain soldiers in the Retired Reserve are considered mobilization assets and can be recalled to active duty. (Office of the Assistant Secretary of Defense (Reserve Affairs), 2000)

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III. FULL-TIME SUPPORT AND THE AGR PROGRAM

A. FULL-TIME SUPPORT PROGRAM OBJECTIVE

The objective of the full-time support program is to improve reserve component readiness, planning, and preparation for mobilization and deployment. This is accomplished by providing full-time support personnel to reserve component units/organizations and Active Army units in support of reserve component missions. (U.S. Army, 1990)

B. HISTORY OF THE FULL-TIME SUPPORT PROGRAM

The employment of full-time support in Army Reserve units began with the passage of the National Defense Act of 1916. Until after World War II, Active Army advisors were the primary source of full-time support. (Stangle, 1988)

In 1950, the Civilian Technician Program was developed to provide junior Department of the Army civilians to replace Active Army personnel who were supporting reserve units. The Civilian Technician Program grew rapidly and soon civilians could be found supporting the commander and primary staff at every level of command. (Stangle, 1988)

In the 1970s, the Active Army developed two concepts that would provide a catalyst for change in full-time support to reserve units. The two concepts, "Total Force" and "One Army," were introduced to provide a deterrence to aggression by developing strong alliances with other countries and by cooperative programs between the Regular Army and the Army Reserve. (Stangle, 1988)

The success of these concepts depended on the Army Reserve's ability to perform to active duty standards. A widespread evaluation of the civilian technician program resulted in an experimental program started by U.S. Army Forces Command (FORSCOM) to convert civilian technician positions to full-time active duty reservists. The program was considered a success after its first year and FORSCOM intended to convert all civilian technician positions to full-time active duty reservists but was stopped by the lobbying efforts of the Civilian Technician Union. The full-time active duty reservists were organized and managed under the Full Time Manning Program. This program later evolved into the AGR Program. (Stangle, 1988)

C. FULL-TIME SUPPORT CATEGORIES TODAY

Today, Full-time support personnel can be categorized as Active Army, Federal Civil Service, or AGR. Active Army personnel assume a full-time support role when expertise in a certain skill is not available in the AGR program. Federal Civil Service positions include military technicians at reserve component units and other civilians who provide administrative, training, maintenance, engineering and analytical support. The AGR program is composed of reserve component soldiers on active duty to support reserve component units or assigned to Active Army units in support of reserve component missions. (U.S. Army, 1990)

AGR positions can be categorized as Indirect Support positions, Direct Support mission manpower positions, and Direct Support manpower positions. Indirect Support AGR personnel include soldiers not assigned to reserve component units (other than recruiters) who are on active duty in support of the reserve component mission. Direct Support mission manpower AGR personnel are assigned to reserve component units and will mobilize and deploy with those units. Direct Support manpower positions involve recruiting and retention programs. (U.S. Army, 1990)

D. THE AGR PROGRAM

Today, AGR personnel provide a majority of all full-time support to the Army Reserve. They can be found at all levels of command, performing functions related to organizing, administering, recruiting, instructing, or training members of the Army Reserve. One significant difference between an active duty reservist and those in the Regular Army is that the Army Reserve AGR is not counted in the end strength of the Active Army.

The policies for establishing and implementing the AGR Program are contained in AR 135-18. The objectives of the AGR program are outlined in AR 140-30, and include:

1. Improve the readiness of Army Reserve units and soldiers through the use of Army Reserve soldiers on active duty. (U.S. Army, 1994a)

2. Develop a force and maintain the expertise of highly qualified, well-trained AGR soldiers. (U.S. Army, 1994a)

3. Operate a centralized personnel management system that will provide for selection, continuation, attachment, training, promotion, and separation of Army Reserve AGR soldiers. (U.S. Army, 1994a)

4. Provide policy guidance to commanders, supervisors, and managers to ensure that Army Reserve AGR soldiers are properly attached, used, trained, and provided career progression opportunities in the AGR program. (U.S. Army, 1994a)

The management of the AGR program within the Army Reserve rests with the Full-Time Support Management Directorate of the Army Reserve Personnel Command. They are responsible for all administration, training, and support of the AGR force.

E. AGR COMPOSITION

The AGR program within the Army Reserve is composed of commissioned officers, warrant officers, and enlisted soldiers. The following are the official strength statistics at the end of FY2001.

Active Guard Reserve Officers	3,611
Commissioned Officers	*3,073*
Warrant Officers	*538*
Active Guard Reserve Enlisted	*9,495*
Total AGR Program	***13,106***

Table 3.1 Composition of the AGR Program at the end of FY 2001 (Source: Defense Manpower Data Center, May 2002)

The AGR enlisted force is the subject of this thesis. At the end of FY2001, the AGR enlisted force within the Army Reserve was composed of the following:

Sergeants Major/Command Sergeants Major (E-9)	160
Master Sergeant/First Sergeant (E-8)	1,075
Sergeant First Class (E-7)	3,624
Staff Sergeant (E-6)	2,451
Sergeant (E-5)	1,908
Specialist Four/Corporal and below (SL1)	277
Total AGR Enlisted Soldiers	***9,495***

Table 3.2 Composition of the AGR Enlisted Force at the end of FY 2001. (Source: Defense Manpower Data Center, May 2002)

IV. AGR ENLISTED MANAGEMENT

A. ACCESSION

1. Sources

Unlike the Regular Army, soldiers entering the Active Guard Reserve (AGR) program must have completed Basic Training and Advanced Individual Training (AIT) and must have a military occupational specialty (MOS) desired by the AGR program or be willing and eligible for re-training in a different job skill. Due to these requirements, Army Reserve Troop Program Units (TPU) and the Individual Ready Reserve (IRR) are the primary sources of new enlisted soldiers entering the AGR program. To a lesser degree, additional accessions are also obtained from the Active Army and the Army National Guard (ARNG).

2. Entrance Board

Each soldier desiring entrance into the AGR program must be board qualified and selected to enter active duty. If the AGR Entrance Board recommends the soldier for entrance into the AGR program, the soldier is placed on an Order of Merit List and will remain on the list for a period of 12 months or until he/she is hired, whichever is shorter. The ranks selected for consideration by the board are at the sole discretion of the Chief, Army Reserve (CAR) and are not defined in any regulation. For FY2002, the CAR has directed that the board consider soldiers in the ranks of Specialist/Corporal (E-4) through Master Sergeant/First Sergeant (E-8).

3. Entrance Training

Each enlisted soldier, unless he/she is a recruiter, is required to attend AGR Entrance Training (AGRET) at Ft. McCoy, WI. The AGRET course is a one-week orientation course designed to conduct in-processing and instruction on various military related topics such as promotions and training management. For FY 2002, there are 19 one-week classes scheduled with a desired maximum student load of 60 students per class. Reserve recruiters, in general, obtain all in-processing and instruction through the Army Recruiter Course at Ft. Jackson, SC.

B. PROMOTION

1. Regulation and Scope

Each enlisted promotion with the AGR program must conform to Army Regulation 140-158 (Enlisted Personnel Classification, Promotion, and Reduction). Since all current AGR authorized positions are in the ranks of Sergeant and above, we will only consider promotion to those ranks in this thesis.

2. Promotion Authority

The authority for promotion to Sergeant rests with the first unit commander in the rank of Lieutenant Colonel (O-5) or above. The promotion to Staff Sergeant and above rests with Headquarters, Department of the Army, Personnel Command.

3. Criteria for Promotion Eligibility

First, a vacancy must exist in the rank to which a soldier will be promoted. Second, the soldier must meet stated civilian and military education requirements. Third, the soldier must have the required number of months of AGR service prior to the promotion zone cut-off date. Fourth, the soldier must meet the requirements of the zone of consideration for promotion. Enlisted soldiers are considered based on the number of months they have served in the same rank and their number of years of military service. This is commonly known as "Time in Grade" (TIG) and "Time in Service" (TIS). Either TIG or TIG and TIS define a soldier's zone of consideration for promotion. These values may change each year based on the needs of the Army. Soldiers meeting all these requirements are considered in the "Primary Zone" (PZ) or "Secondary Zone" (SZ) for promotion. Table 4.1 provides a typical example of promotion zone criteria for FY2002 for promotions to Staff Sergeant through Sergeants Major.

Rank	*TIG – PZ* *(months)*	*TIG – SZ* *(months)*	*TIS – PZ* *(years)*	*TIS – SZ* *(years)*
SSG (E-6)	≥ 15	12 < TIG < 15	NONE	NONE
SFC (E-7)	≥ 33	21 < TIG < 33	NONE	NONE
MSG (E-8)	≥ 40	30 < TIG < 40	≥ 11	NONE
SGM (E-9)	≥ 40	30 < TIG < 40	≥ 14	NONE

Table 4.1 TIG and TIS requirements for promotion consideration to Staff Sergeant and above.

The zone of consideration is applicable for the ranks of Staff Sergeant and above, but not for Sergeant. Since there is only one zone of consideration for Sergeants, the terms "Primary Zone" and "Secondary Zone" are not used. To be in the zone for promotion to Sergeant, a soldier must have 8 or more months TIG as an E-4 (waiverable to 4 months) and 24 or more months TIS (waiverable to 12 months).

Fifth, an additional criterion that defines a soldier's eligibility for promotion is years of Active Federal Service (AFS). In general, soldiers approaching the point where they will be forced to retire are not considered for promotion. The maximum number of years of AFS an enlisted soldier may have in order to be considered for promotion is based on rank and is shown in Table 6 below.

For Promotion to:	**AFS (Years)**
Sergeant (E-5)	19
Staff Sergeant (E-6)	19
Sergeant First Class (E-7)	19
Master Sergeant/First Sergeant (E-8)	21
Sergeants Major/Command Sergeants Major (E-9)	23

Table 4.2 Maximum AFS for promotion consideration

4. Conditional Promotion

Within the Army Reserve, an enlisted soldier can be promoted to the ranks Sergeant through Sergeants Major on the condition that the soldier enrolls and successfully completes the required military education in a certain period of time. Should the soldier fail to fulfill the requirements of the conditional promotion, the soldier will be reduced to the previous rank.

C. REDUCTION

The term "reduction" refers to a decrease in rank or pay grade. Reductions may happen for various reasons. A soldier may be reduced due to not fulfilling the requirements of a conditional promotion, inefficiency, civil conviction, or military conviction. Additionally, a soldier may ask for a voluntary reduction to obtain an AGR tour or for entry into the Active Army. When a soldier is reduced, they will retain the original date of rank for the rank to which reduced.

D. SEPARATION

The term "separation" refers to a soldier leaving the AGR program for any reason, some of which are listed below.

1. Each soldier enlists for a three year period when initially entering the AGR program. At the end of three years, the soldier may choose to reenlist or leave the AGR program. (U.S. Army, 1997)

2. After 20 years of AFS, a soldier is eligible for retirement. Although eligible, a soldier is not forced to retire until he/she reaches their retention control point (RCP). The RCP is the maximum number of years a soldier may remain on active duty, and is defined based on rank. An enlisted soldier cannot serve more than 29 days of AFS past the RCP for their current rank. Table 7 below shows the current RCP for each rank. (U.S. Army, 1997)

Rank	AFS (Years)
Staff Sergeant (E-6) or below	20
Sergeant First Class (E-7)	22
Master Sergeant/First Sergeant (E-8)	24
Sergeants Major/Command Sergeants Major (E-9)	26

Table 4.3 Retention Control Points (From: AR 140-111)

3. A soldier may be forced to involuntarily separate the AGR program due to reductions in force. This kind of separation is commonly known as a programmed or managed loss (PML). (U.S. Army, 1994)

4. Enlisted soldiers identified by the Qualitative Management Program as non-progressive and non-productive may be denied the opportunity to re-enlist in the AGR program. (U.S. Army, 1997b)

5. Medical or administrative related issues may cause some enlisted soldiers to be released from the AGR program.

6. Enlisted soldiers may ask for voluntary early separation before their term of service has expired.

7. Enlisted soldiers are forced to separate due to reaching the maximum age limit for continued service, which is currently 60 years old. (U.S. Army, 1997)

E. MILITARY OCCUPATIONAL SPECIALTY (MOS) AND CAREER MANAGEMENT FIELDS (CMF)

A soldier's job skill is known as his/her MOS. A soldier may have one or many MOS's. In general, the AGR program only looks at three MOS. Those MOS are a soldier's primary, secondary, and additional MOS. A soldier's primary MOS is the principal job for which the soldier is trained, the others are additional job skills the soldier may possess. Generally, soldiers are most proficient in their primary MOS. (U.S. Army, 1997a)

Each MOS belongs to a family of MOS known as a CMF. For example, an Intelligence Analyst (MOS 96B) and Counter-Intelligence Agent (MOS 97B) belong to

CMF 96 (Military Intelligence). While there are over 200 MOSs, there are fewer than 32 CMFs. (U.S. Army, 1999) The CMF level of detail is used in this thesis.

F. RECLASSIFICATIONS AND SUBSTITUTION

The term "reclassification" refers to changing the primary or secondary MOS for which an enlisted soldier is trained. A reclassification may happen when entering the AGR program or while serving on AGR status. When entering the AGR program, soldiers in the rank of SPC through SSG may reclassify if they meet the pre-requisites for an under-strength MOS. Soldiers in the rank of SFC may only reclassify to MOS 79R (Recruiter) or 79V (Retention NCO) when entering the program. (FTSMD, 2001e) While serving in the AGR program, reclassifications may happen as a result of the soldier obtaining new skills, promotion, or the needs of the Army. The primary focus on a reclassification is whether it benefits the Army and the soldier. (U.S. Army, 1997a)

The term "substitution" refers to the interchangeability of one MOS for another in the same rank. For example, MOS 95B (Military Police) and MOS 95C (Corrections Specialist) are substitutable at each rank. In another example, MOS 11M (Fighting Vehicle Infantryman) possesses the skills to substitute for MOS 11B (Infantryman), MOS 11C (Indirect Fire Infantryman), or MOS 11H (Heavy Anti-armor Weapons Infantryman) at each rank. However, soldiers in MOS 11B, 11C, or 11H do not possess the skills to substitute for MOS 11M. Most MOS have no substitutability and for those that do, the substitutability is confined within the CMF. (U.S. Army, 1999b)

G. AGR FORCE STRUCTURE

The force structure in the AGR program is much different from that of the Active Army. While the majority of Active Army positions are at ranks Private through Specialist, the majority of AGR enlisted positions are at Sergeant First Class. Figure 4.1 displays the current AGR enlisted force structure and Figure 4.2 displays a comparison of the current strength with the authorized force structure. Since Command Sergeant Majors (MOS 00Z) and CMF immaterial Sergeant Major positions (MOS 00D) are not CMF specific, they are outside the scope of this thesis.

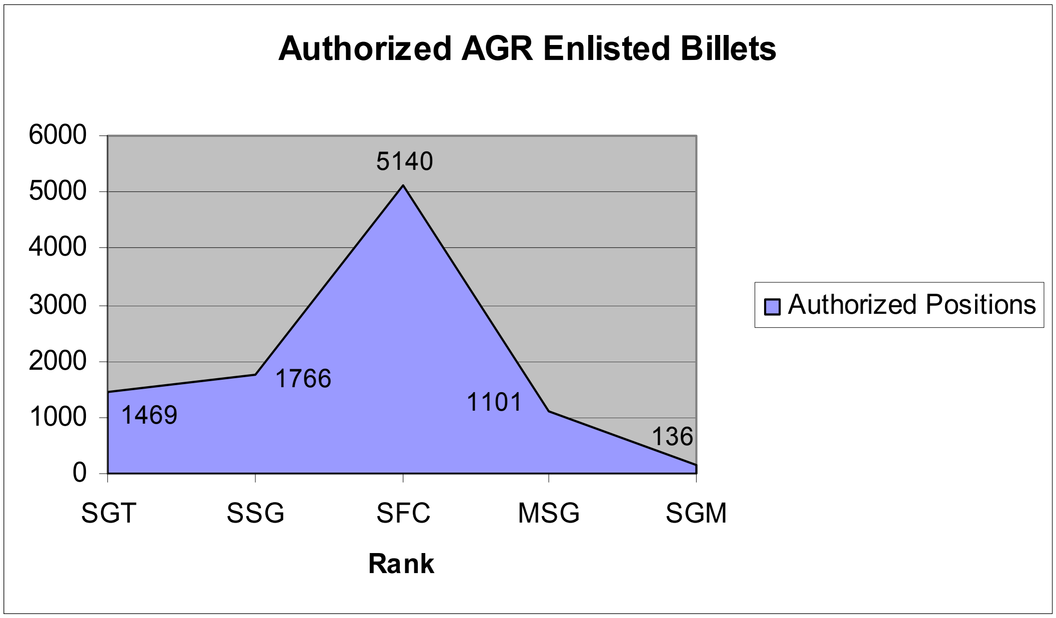

Figure 4.1 Authorized AGR Enlisted Billets (Source: AGRMIS, 2001)

The graph demonstrates a triangular shaped distribution of ranks. The AGR program was not designed as a career program. The structure of the force suits the needs of the units instead of the needs of career development and advancement. Many CMFs have no positions at higher ranks and many at lower ranks. This creates an obstacle to career advancement that, at times, may only be addressed through reclassification or leaving the program. Although great strides have been made in recent years to solve this problem, the program still provides great opportunities in some career fields and little in others.

An example of the problems that exist is found in CMF 63 (Mechanical Maintenance). An examination of the force structure shows 394 Sergeant, 262 Staff Sergeant, and 543 Sergeant First Class positions. A structure such as this makes promotion to Staff Sergeant very difficult but there is great potential for promotion to Sergeant First Class once a soldier reaches Staff Sergeant. The difficulty presented by this force structure will most likely facilitate filling many of the Sergeant First Class positions through new accessions. This is one example but many others exist.

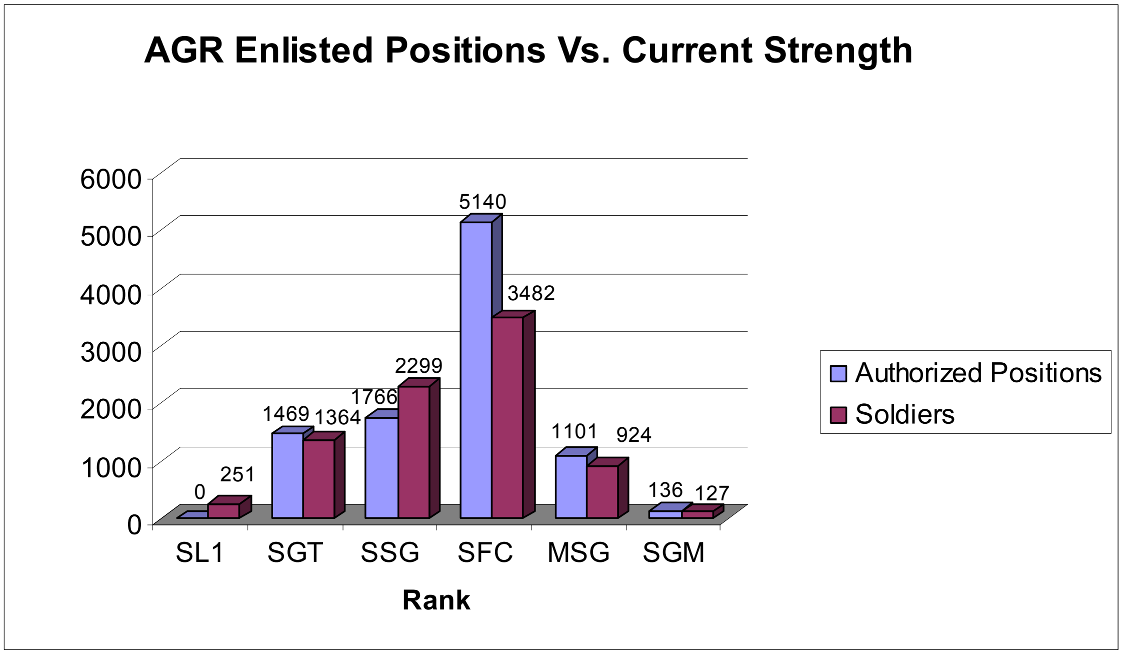

Figure 4.2 AGR Enlisted Authorized Vs. Current Strength (From: AGRMIS, December 2001)

V. OPERATIONS RESEARCH MODELS FOR MILITARY MANPOWER PLANNING

A. THE AGR ENLISTED MANPOWER PROJECTION MODEL (EMPM)

1. Methodology

The AGR EMPM can best be described as a weighted goal programming model. The model optimizes to achieve selected goals such as the annual end strength objective and force mix requirements while reducing forced separations and reclassifications. “Goal programming is the most popular approach to dealing with multi-objective optimization problems because it reduces complex multi-objective tradeoffs to a standard, single-objective, mathematical program in a way that decision makers often find intuitive” (Rardin, 1998). Military manpower planning models often use this technique due to the multi-objective nature of the problem and the desire to achieve optimal results over time

2. Network Representation

Since the model allows attrition or rather seepage of personnel, EMPM is considered a generalized network. Each node represents a valid rank, CMF, AFS, and TIG combination. Each arc represents the movement of personnel through a variety of different career paths from remaining in the current career field at the same rank, remaining in the current career field with a promotion in rank, to reclassifying to a different career field at the same rank, and to voluntarily or involuntarily leave the AGR program. A network diagram is shown in Figure 5.1.

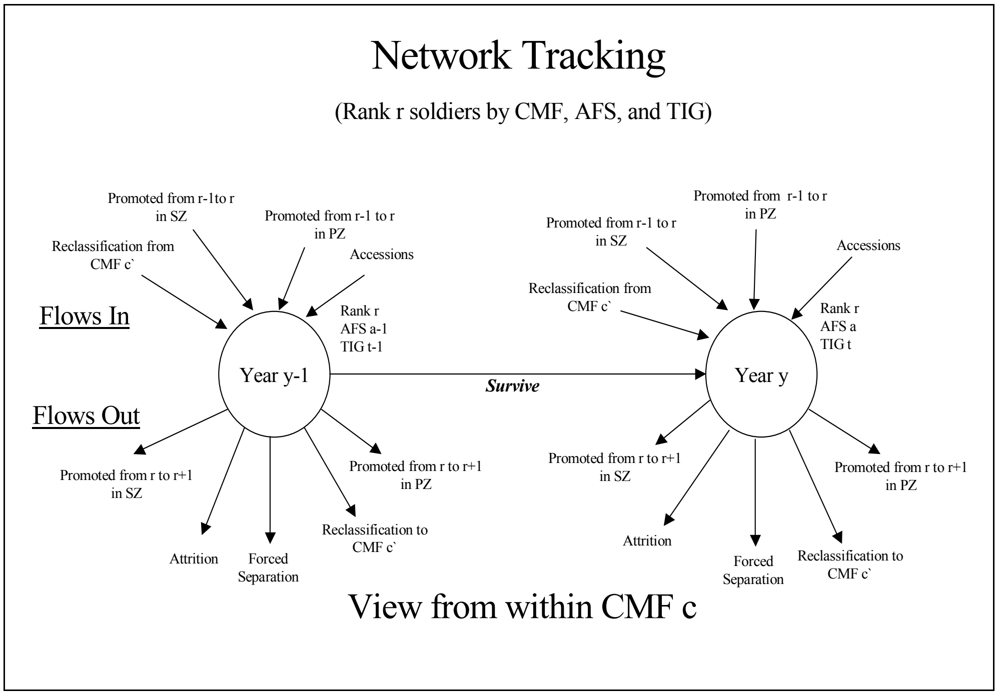

Figure 5.1 EMPM Network Representation

B. LITERATURE REVIEW

The topic of military manpower modeling has been intensely studied by operations researchers throughout the years. This literature review is organized into three sections: Army Reserve Manpower Modeling, Army Manpower Modeling, and Other Service/Country Manpower Modeling.

1. Army Reserve Manpower Modeling

Our search for Army Reserve Manpower Models yielded two articles and one thesis. In the first article, Shukiar (1996) develops a Markov based spreadsheet model used for personnel projection of the Reserve Components. This work tries to balance shortages of personnel to meet minimum duty MOS qualification rates needed for deployment and to determine whether that balance would be effective in a conflict with an Active and Reserve Component much smaller than that used during the Gulf War. The report also addresses how duty MOS qualification rates might be increased to reduce the need to balance personnel shortages in future conflicts by improvements in the use of prior active duty personnel.

The second article, by Reeves and Reid (1998), describes the development of a multi-objective manpower planning model to implement the goals of a company sized reserve unit. The goals of the model are to minimize the unit staff who do not have the required special schooling, underachievement of special training, and underachievement of required training while maximizing military education and mutual support missions. The decision variables in the model represent the number of soldiers in each rank, skill level, and military education level assigned to each activity during each period of a 12 month planning horizon. The Litzenberg thesis (2001) develops a linear manpower planning model for the Active Guard Reserve officer corps of the Army Reserve to measure the feasibility of position vacancy promotions and retaining AGR officers beyond 20 years of AFS.

As for models currently being used by the Army Reserve, the Army Reserve Personnel Command (AR-PERSCOM) developed an AGR officer manpower model in SAS that simulates accessions, promotions, and assignments through the use of a transportation type network. The model aggregates by rank and 2-digit Branch Code. For example, officers with the area of concentration (AOC) 35D (All Source Intelligence) and AOC 35E (Counter Intelligence) would be aggregated into Branch 35 (Military Intelligence). The model provides detailed reports on various topics and, due to advances in computing technology, solves relatively quickly. (Marmorstein, 2001)

Each model listed above was developed to address a specific reserve manpower problem. Since it is spreadsheet based, the Shukiar model does not meet the dimensional requirement of the AGR enlisted problem. The Reeves and Reid model uses multi-objective optimization but addresses small unit manpower planning while the needs of the AGR enlisted force are much larger. The AR-PERSCOM model addresses the AGR officer problem by using simulated assignments through a transportation network. This is an approach to addressing the AGR enlisted problem but is not the desired optimization approach. The Litzenberg model comes the closest to providing the necessary dimensionality and methodology to address the AGR enlisted problem. This model, however, does not meet the needs of the AGR enlisted force since the management of the AGR officer and enlisted force are so different.

2. Army Manpower Modeling

The majority of military manpower modeling discovered in our literature search deals with Active Army manpower problems. For example, Eiger, Jacobs, Chung, and Selsor (1988) describe a "combined linear optimization-simulation personnel flow model" that is used as a "personnel strength management tool to achieve force alignment" and to provide recommendations on enlisted promotions, reclassifications, and reenlistments.

Durso and Donahue (1995) describe the development and implementation of the Total Army Personnel Life Cycle Model (TAPLIM) by the Office of the Deputy Chief of Staff for Personnel, U. S. Army. This linear programming model, developed by COL Anthony Durso, USA (retired) while assigned to Rand Corporation as a Research Fellow in 1990, was used to optimize the Army's force reduction in the early 1990's and conduct analysis on the effects of numerous manpower policies.

Our search discovered two Naval Postgraduate School theses relating to Army Manpower Modeling. The first, Yamada (2000), develops an optimization model to manage Active Army officers. The model recommends promotions, accessions, and separations to meet manpower planning targets and is used to measure the effect of manpower policies. The second, Corbett (1995), develops a weighted goal programming model to assist the Army's Officer Personnel Management Directorate in forecasting yearly officer accessions and balancing strength in lieutenants among the Army's career branches.

None of the Active Army models discussed above meet the unique requirements of the AGR enlisted problem. The Durso model was developed to address accessions at SL1 and assignment location. The AGR enlisted problem has a random accession process with accessions occurring at most any grade, few accessions at SL1, and no assignment locations. The Yamada and Corbett models are much too aggregated to address the AGR enlisted problem. The Eiger *et al.* (1988) model uses simulation and optimization at the MOS and rank level of detail while the AGR enlisted manpower problem requires optimization by rank and CMF. In addition, accessions at levels other than SL1 are not addressed.

3. Other Service and Country Manpower Modeling

Among the other branches of the U.S. military, three Naval Postgraduate School master's theses and one Rand publication were discovered dealing with military manpower modeling. Bolton (1998) develops an Excel based model for the Marine Corps using years of service and pay grade to project personnel strength where attrition, promotion, and demotion rates are straight or weighted averages. Rodgers (1991) develops a multi-objective linear programming model to project Navy personnel inventories, promotions, and recruiting goals. The model also incorporates various budgetary and force structure restrictions imposed by Congress. Fiebrandt (1993) develops a Markov based "vacancy personnel model" for the Coast Guard. The model, called "Coast Guard Rating Forecast Model," is used to project the inventory and personnel flow for each rating and determine the average TIS until promotion using linear regression. The last document located was the Rand publication authored by Warren E. Walker and the Enlisted Force Management Project Team (1991). The publication describes the development of a suite of models to handle personnel related problems for the Air Force. The two most notable of these models are the Authorization Projection Model (APM) and the Grade Allocation Model (GAM). The APM was designed to project enlisted manpower authorizations in future years. The GAM was developed to balance mission demand against personnel constraints.

The only publications discovered addressing a foreign military manpower problem was the Naval Postgraduate School master's thesis by Suryadi (1990). The model that was developed was a two-dimensional Markov based model using pay grade and TIG. Some of the model outputs include officer inventory and promotion rates to each rank.

None of the models reviewed in this section solve the AGR enlisted manpower problem due to dimensional problems, unique accession and management issues, and/or differences experienced due to country or service.

C. ASSUMPTIONS AND INPUT DATA

1. Enlisted Inventory

The force of AGR enlisted soldiers is very dynamic. On any day, soldiers are entering the AGR program, retiring, being promoted, changing positions, or changing units. From a manpower management perspective, it is not beneficial to account for these soldiers on each day of the year. The AGR EMPM accounts for enlisted soldiers at the end of each year of the planning horizon.

2. Enlisted Aggregation and Classification

The AGR EMPM aggregates soldiers with like characteristics. Instead of tracking individual soldiers as they traverse the system, the model tracks groups of soldiers with like characteristics as they flow through the network. To facilitate this method of personnel tracking, soldiers are aggregated by rank, CMF, AFS, and TIG.

The classification of soldiers into these groups is based on defined rules and policies. For convenience since the TIG is only used to determine promotion zone eligibility, the TIG for each rank remains constant after the first full year in the primary promotion zone. The maximum TIG for each rank is assumed to contain everyone at that TIG and over. Appendix A gives the enlisted inventory aggregated by AFS and TIG for each rank as of December 2001.

The limit on AFS is based on RCPs established by Army Regulation and displayed in Table 4.3 in Chapter IV. It is possible for a soldier to have 2 yrs TIG and 20 years of AFS, 5 years TIG and 2 years AFS, or many more combinations since TIG can accumulate while a soldier is not on active duty. For this reason, the model does not place any conditions on combinations of TIG or AFS except that they must fall within the range of allowable values denoted by the model.

3. Accessions

The model handles accessions into the AGR program by developing a pool of potential accessions by rank, CMF, AFS, and TIG. The rank, CMF, TIG, and AFS for soldiers in the accession pool conform to a historical distribution. The ranks allowed to join the AGR program are user defined. For the purposes of this thesis, the ranks allowed to enter the AGR program are SL1 through SFC. The AFS distribution limits those entering the AGR program to no more than 13 years of previous AFS. (U.S. Army, 1996)

The number of soldiers available for accession into the AGR program is random with an upper bound and lower bound. The upper and lower bound are derived from historical information on AGR Entrance Board selection and additional accession information provided by OCAR, Retention and Transition Division relating to CMF 79. It is assumed that no accessions of SL1 and SGT are possible in CMF 79.

To address the limitations of training resources, the model constrains accessions to meet current training seat requirements. According to the leadership at U.S. Army Reserve Training Center at Ft. McCoy, WI, AGRET should have no more than 60 personnel per class. With 19 AGRET classes scheduled for FY2002, this translates into an overall bound of 1140 total soldiers eligible to be trained for both officer and enlisted. The proportion of those seats that will be filled by enlisted is a user defined input and can fluctuate with projected enlisted vacancies in the force. Currently, the value is set to 100% to give the enlisted force perfect training opportunities.

4. Separation

Separation includes normal attrition, forced separation, and retirement. Normal attrition refers to those soldiers leaving the AGR program for reasons other than forced separation. This includes expiration term of service and administrative discharges. The rates used are based on historical attrition by rank and AFS for a period of 9 years. The attrition coefficients are shown in Appendix B. Due to insufficient data, attrition rates for MSG below 7 years AFS and SGM below 14 years AFS are notional.

Forced separation in the current time period is limited by the inventory that survived normal attrition from the previous time period and policies on forced separation that are in effect. Although not defined in any regulation, this thesis specifies a minimum and maximum AFS and a minimum TIG as policies for forced separation. This thesis does not specify a forced separation rate as a certain policy.

5. Promotion

The qualification for promotion in the PZ and SZ are by Army Regulations. The ranks to which PZ promotion is authorized are SGT through SGM. The ranks to SZ promotion is authorized are SSG through SGM. Due to the need to meet AGR service requirements, SL1 soldiers are promoted with at least 1 year TIG. This promotion will happen in the second year. Even though the model supports establishment of an upper bound on promotion, this thesis assumes no upper or lower bound on PZ or SZ promotion.

6. Reclassification and Substitution

The ranks allowed to reclassify in the model are SL1 through SFC. In addition, all reclassifications happen after being accessed into the AGR program. The model supports constraint of reclassifications by CMF, however, this thesis assumes no limitation on those CMFs eligible to reclassify.

7. Force Structure

As described in Chapter IV, AGR force structure is very dynamic. As with initial inventory, force structure inputs to the model are aggregated by rank and CMF. By handling force structure in this manner, force structure requirements can be matched to personnel strength and deficiencies can be noted. This is commonly called "matching faces to spaces"(Durso and Donahue, 1995). Further, the model handles structure on a yearly basis so force structure changes can be instituted in the current year or any other year in the planning horizon. For the purposes of this thesis, the force structure remains constant for the entire planning horizon.

8. Governmental Policy Implementation

The overall strength, composition, and funding of the AGR force is subject to yearly limitations imposed by public law in the form of the National Defense Act. The law limits the AGR program by man-years, yearly end strength, and places upper bounds on senior officers and enlisted. A man-year is defined as one soldier serving on active duty for one year. This budgetary constraint is outside the scope of this thesis but could be easily implemented should future requirements dictate. The yearly end strength addresses both the officer and enlisted force and can be defined as those soldiers on active duty at the end of the fiscal year. The limitation on senior enlisted strength refers to the proportion of soldiers in the ranks of Master Sergeant and Sergeant Major compared to overall end strength for the fiscal year. The authorized end strength for the

AGR program in the Army Reserve is 13,406 for fiscal year 2002. The senior enlisted sergeants in AGR program for fiscal year 2002 are limited to approximately 1300 Master Sergeants and approximately 197 Sergeant Majors. For the purposes of this thesis, the end strength target is 100% of the authorized force structure and the senior enlisted constraint is no more than 100% of the authorized MSG and SGM force structure.

9. Stop Loss Implementation

In times of national emergency, many soldiers with critical skills are forced to remain in AGR program beyond their term of service or retirement date. This action to ensure Army Reserve readiness is known as a "stop loss". In general, a "stop loss" affects MOSs that are critical within the Army and Army Reserve. This thesis assumes a "stop loss" affects the AGR enlisted force by rank and CMF.

10. Penalties

The penalties in the objective function address reclassification, PML, over CMF target, under CMF target, and not meeting the yearly end strength target. The assignment of penalties is subjective but conform to the general goal of reducing reclassifications and PML while meeting the CMF and yearly end strength targets. The nominal values of the penalties used in the model are reclassification (25), PML (2), over CMF target (20), under CMF target (20), and not meeting yearly end strength (2). Sensitivity analysis on the weights is discussed in Chapter VII.

D. MODEL FORMULATION

1. Indices

r Ranks (SL1,SGT,SSG,SFC,MSG,SGM)

c Career Management Field (11=Infantry, 12=Combat Engineer,…, 98=SIGINT/EW)

a Active Federal Service (AFS) (*a*01,..,*a*26) in years

t Time In Grade (TIG) (*t*01,…,*t05*) in years

y Year of the planning horizon (y00,..y07)

2. Sets

$STOP_{r,c,y}$	set of rank *r,* CMF *c*, and year y combinations that are part of the stop loss
$SENIOR_r$	set of ranks *r* considered senior enlisted
$RRECL_r$	set of ranks *r* for which reclassification is authorized
RPZ_r	set of ranks *r* for which PZ promotion is authorized
RSZ_r	set of ranks *r* for which SZ promotion is authorized
$RBILLET_r$	set of ranks *r* that have authorized billets
$RACC_r$	set of ranks *r* for which accession is authorized
$SZTIG_{r,t}$	set of ranks *r* and TIG *t* combinations for which SZ promotion is authorized
$PZTIG_{r,t}$	set of ranks *r* and TIG *t* combinations for which PZ promotion is authorized
$XAFS_{r,a}$	set of authorized rank *r* and AFS *a* combinations
$XTIG_{r,t}$	set of authorized rank *r* and TIG *t* combinations
$RCTR_c$	set containing recruiting and retention CMF
$YFIRST_y$	first year of the planning horizon

3. Parameters

α_y	discount factor $0 \leq \alpha \leq 1$, derived as $1/(1 + (1\text{- Rate}))^{y}$
$\text{Att}_{r,a}$	attrition rates by rank *r* and AFS *a*
Rcp_r	retention control point for rank *r* (i.e. maximum AFS for rank *r*)

$SenMax_{r,y}$ end strength allotted to rank $r \in SENIOR_r$ in year y of the planning horizon

$Billets_{r,c,y}$ available billets in rank r of CMF c in year y of the planning horizon

$YTgt_y$ target end strength in year y of the planning horizon

$Enlisted_y$ enlisted proportion of total end strength in year y of the planning horizon

$Agret_y$ maximum number of training seats available in AGR Entrance Training during year y of the planning horizon

$AfsMx_r$ maximum AFS for rank r to be promoted to rank $r+1$

$SzUb_{r,c}$ upper bound on SZ promotion for rank r in CMF c

$PzUb_{r,c}$ upper bound on PZ promotion for rank r in CMF c

$PzElig_{r,t}$ proportion eligible for PZ promotion with rank r and TIG t

$SzElig_{r,t}$ proportion eligible for SZ promotion with rank r and TIG t

$TigMax_r$ maximum TIG for rank r

4. Scalars

StopLoss stop reclassifications and forced separations during stop loss scenario

Rate rate used to develop discount factor (α_y)in the objective function

AfsReclMx maximum AFS to allow reclassifications

AfsReclMn minimum AFS to allow reclassifications

AfsPmlMx maximum AFS to allow forced separations

AfsPmlMn minimum AFS to allow forced separations

AfsAccMx	maximum AFS to allow accessions
TigPmlMn	minimum TIG to allow forced separations
TigReclMn	minimum TIG to allow reclassifications
PenPml	penalty used in the objective function for forced separation
PenRecl	penalty used in the objective function for reclassification
PenYr	penalty used in the objective function for not achieving yearly end strength
PenCmfO	penalty used in the objective function for over achieving CMF yearly target strength
PenCmfU	penalty used in the objective function for under achieving CMF yearly target strength

5. Variables

a) Inventory

$X_{r,c,a,t,y}$	total enlisted inventory in rank *r* of CMF *c* with AFS *a* and TIG *t* at the end of year *y* of the planning horizon

b) Personnel Action

$PZ_{r,c,a,t,y}$	number of PZ promotions from rank *r-1* to rank *r* with CMF *c* , TIG *t*, and AFS *a* during year *y* of the planning horizon
$SZ_{r,c,a,t,y}$	number of SZ promotions from rank *r-1* to rank *r* with CMF *c*, TIG *t*, and AFS *a* during year *y* of the planning horizon
$ACC_{r,c,a,t,y}$	number of accessions with rank *r* , CMF *c*, AFS *a,* and TIG *t* during year *y* of the planning horizon
$RECLIN_{r,c,a,t,y}$	number of reclassifications into CMF *c* with rank *r*, AFS *a*, and TIG *t* during year *y* of the planning horizon

$RECLOUT_{r,c,a,t,y}$	number of reclassifications out of CMF *c* with rank *r*, AFS *a* and TIG *t* during year *y* of the planning horizon
$PML_{r,c,a,t,y}$	number of forced separations from CMF *c* with rank *r*, AFS *a*, and TIG *t* during year *y* of the planning horizon

c) Deficiency

$OCTGT_{r,c,y}$	number of personnel over CMF strength target in rank *r* of CMF *c* at the end of year *y* of the planning horizon
$UCTGT_{r,c,y}$	number of personnel under CMF strength target in rank *r* of CMF *c* at the end of year *y* of the planning horizon
$OYTGT_{y}$	number of personnel over the enlisted end strength target at the end of year *y* of the planning horizon
$UYTGT_{y}$	number of personnel under the enlisted end strength target at the end of year *y* of the planning horizon

6. The Objective Function

The goal of the objective function is to minimize the discounted and weighted deviations between enlisted strength targets in the areas of force structure and end strength while minimizing the penalties for forced separations and reclassifications.

$$\begin{aligned}
MINIMIZE \quad & \sum_{\substack{r \in RBILLET_r, \\ c, y \notin YFIRST_y}} \alpha_y * (\text{PenCmfO}*OCTGT_{r,c,y} + \text{PenCmfU}*UCTGT_{r,c,y}) + \qquad (5.1) \\
& \text{PenYr} * \sum_{y \notin YFIRST_y} \alpha_y * (OYTGT_y + UYTGT_y) + \\
& \text{PenPml} * \sum_{\substack{\text{AfsPmlMn} \le a \le \text{AfsPmlMx}, \\ r, y \notin YFIRST_y, c, t}} \alpha_y * PML_{r,c,a,t,y} + \\
& \text{PenRecl} * \sum_{\substack{r \in RRECL_r, \\ \text{AfsReclMn} \le a \le \text{AfsReclMx}, \\ t, y \notin YFIRST_y}} \alpha_y * (RECLIN_{r,c,a,t,y} + RECLOUT_{r,c,a,t,y})
\end{aligned}$$

7. The Constraints

a) Inventory Balance

The inventory balance constraints forecast the enlisted inventory at the end of each year of the planning horizon. Depending on personnel actions taken, the number of enlisted soldiers in the AGR program with rank r of CMF c with AFS a and TIG t at the end of year y is equal to the number of enlisted soldiers in rank r of CMF c with AFS a-1 and TIG t-1 who survive normal attrition from year y-1 to year y, plus the number of enlisted soldiers that are promoted to rank r (TIG 1) in the primary and secondary zones, reclassify from other CMFs into CMF c during year y, or are accessed into the AGR program with rank r of CMF c with AFS a and TIG t, minus those promoted to rank r+1 in the primary and secondary zones minus those who reclassify out of CMF c or are forced to separate during year y. If a rank r and CMF c are members of the stop-loss, no normal attrition will be applied from year y-1 to year y.

$$
\begin{aligned}
X_{r,c,a,t,y} = {} & (1-\text{Att}_{r,a}\big|_{(r,c,y)\notin STOP_{r,c,y}})*X_{r,c,a-1,t-1,y-1} + (1-\text{Att}_{r,a}\big|_{(r,c,y)\notin STOP_{r,c,y}})*X_{r,c,a-1,t,y-1}\big|_{t=\text{TigMax}_r} \qquad (5.2)\\
& - PZ_{r+1,c,a,t,y}\big|_{(r+1,t)\in PZTIG_{r+1,t},a\le \text{AfsMx}_{r+1}} - SZ_{r+1,c,a,t,y}\big|_{(r+1,t)\in SZTIG_{r+1,t},a\le \text{AfsMx}_{r+1}}\\
& + ACC_{r,c,a,t,y}\big|_{r\in RACC_r,a\le \text{AfsAccMx}} - PML_{r,c,a,t,y}\big|^{(r,c,y)\notin STOP_{r,c,y},t\ge \text{TigPmlMn}}_{\text{AfsPmlMn}\le a\le \text{AfsPmlMx}}\\
& - RECLOUT_{r,c,a,t,y}\big|^{t\ge \text{TigReclMn},(r,c,y)\notin STOP_{r,c,y}}_{r\in RRECL_r,\text{AfsReclMx}\ge a\ge \text{AfsReclMn}} + RECLIN_{r,c,a,t,y}\big|^{t\ge \text{TigReclMn}}_{r\in RRECL_r,\text{AfsReclMx}\ge a\ge \text{AfsReclMn}}\\
& + \sum_{t`:(r,t`)\in PZTIG_{r,t`},a\le \text{AfsMx}_r} PZ_{r,c,a,t`,y}\big|_{t=1} + \sum_{t`:(r,t`)\in SZTIG_{r,t`},a\le \text{AfsMx}_r} SZ_{r,c,a,t`,y}\big|_{t=1}\\
& \forall c,(r,a)\in XAFS_{r,a},(r,t)\in XTIG_{r,t}, y\ne YFIRST_y
\end{aligned}
$$

b) Promotion Eligibility

The purpose of promotion eligibility constraints is to limit those that are considered for promotion to only those personnel that are eligible. Equation (5.3a) limits the eligibility for PZ promotion to a proportion (**PzElig**$_{r,t}$) of the population that survived normal attrition from the previous time period. After the first year of eligibility, a soldier will always be in the PZ until promoted, attrited, or retired. Equation (5.3b) limits those eligible for SZ promotion to a proportion of the population that survived normal attrition from the previous period. One should notice that all soldiers remaining in the SZ without getting promoted make a seamless transition to the PZ.

$$PZ_{r,c,a,t,y} \leq \text{PzElig}_{r,t} * (1 - \text{Att}_{r-1,a}\big|_{(r,c,y)\notin STOP_{r,c,y}}) * X_{r-1,c,a-1,t-1,y-1} + \text{PzElig}_{r,t} * (1 - \text{Att}_{r-1,a}\big|_{(r,c,y)\notin STOP_{r,c,y}}) * X_{r-1,c,a-1,t,y-1}\big|_{t=\text{TigMax}_r} \quad (5.3a)$$

$$\forall 2 \leq a \leq \text{AfsMx}_r, (r,t) \in PZTIG_{r,t}, y \neq YFIRST_y$$

$$SZ_{r,c,a,t,y} \leq \text{SzElig}_{r,t} * (1 - \text{Att}_{r-1,a}\big|_{(r,c,y)\notin STOP_{r,c,y}}) * X_{r-1,c,a-1,t-1,y-1} \quad (5.3b)$$

$$\forall c, 2 \leq a \leq \text{AfsMx}_r, y \neq YFIRST_y, (r,t) \in SZTIG_{r,t}$$

c) *Combined Promotion*

The purpose of Equation (5.4) is to limit the total promotions within each year to those available for promotion from the previous time period. This constraint is necessary since soldiers in the primary and secondary zones may be considered within the same year.

$$PZ_{r,c,a,t,y} + SZ_{r,c,a,t,y} \leq (1 - \text{Att}_{r-1,a}\big|_{(r,c,y)\notin STOP_{r,c,y}}) * X_{r-1,c,a-1,t-1,y-1} + (1 - \text{Att}_{r-1,a}\big|_{(r,c,y)\notin STOP_{r,c,y}}) * X_{r-1,c,a-1,t,y-1}\big|_{t=\text{TigMax}_r} \quad (5.4)$$

$$\forall c, 2 \leq a \leq \text{AfsMx}_r, y \neq YFIRST_y, (r,t) \in PZTIG_{r,t}, (r,t) \in SZTIG_{r,t}$$

d) *Promotion Upper-Bound*

Equation (5.5a) places an upper bound on the total number of promotions by rank and CMF in the PZ. Equation (5.5b) accomplishes the same for the SZ.

$$\sum_{\substack{2\le a\le \text{AfsMx}_r,\\ t:(r,t)\in PZTIG_{r,t}}} PZ_{r,c,a,t,y} \le \text{PzUb}_{r,c} * \Big(\sum_{\substack{2\le a\le \text{AfsMx}_r,\\ t:(r,t)\in PZTIG_{r,t}}} \text{PzElig}_{r,t} * (1-\text{Att}_{r-1,a}\big|_{(r,c,y)\notin STOP_{r,c,y}}) * (X_{r-1,c,a-1,t-1,y-1}) \qquad (5.5a)$$

$$+ \sum_{\substack{2\le a\le \text{AfsMx}_r,\\ t:(r,t)\in PZTIG_{r,t}}} \text{PzElig}_{r,t} * (1-\text{Att}_{r-1,a}\big|_{(r,c,y)\notin STOP_{r,c,y}}) * (X_{r-1,c,a-1,t,y-1})\big|_{t=\text{TigMax}_r} \Big)$$

$\forall r, c, y \ne YFIRST_y$

$$\sum_{\substack{2\le a\le \text{AfsMx}_r,\\ t:(r,t)\in SZTIG_{r,t}}} SZ_{r,c,a,t,y} \le \text{SzUb}_{r,c} * \sum_{\substack{2\le a\le \text{AfsMx}_r,\\ t:(r,t)\in SZTIG_{r,t}}} \text{SzElig}_{r,t} * (1-\text{Att}_{r-1,a}\big|_{(r,c,y)\notin STOP_{r,c,y}}) * (X_{r-1,c,a-1,t-1,y-1}) \qquad (5.5b)$$

$\forall r, c, y \ne YFIRST_y$

e) Career Management Field Target

The purpose of Equation (5.6) is to ensure that personnel strength by rank and CMF is compared to the billets by rank and CMF. In general, the equation compares "Faces"(personnel) to "Spaces"(billets). The deficiency variables $\mathbf{OCTGT}_{r,c,y}$ and $\mathbf{UCTGT}_{r,c,y}$ measure the amount over and under the desired target. These variables are minimized in the objective function.

$$\sum_{a\le \text{Rcp}_r, t} (X_{r-1,c,a,t,y}\big|_{r=SGT} + X_{r,c,a,t,y}) - OCTGT_{r,c,y} + UCTGT_{r,c,y} = \text{Billets}_{r,c,y} \qquad (5.6)$$

$\forall r \in RBILLET_r, c, y \ne YFIRST_y$

f) Yearly Target End Strength

Equation (5.7) compares the total enlisted inventory to an established enlisted end strength target. The deficiency variables $\mathbf{OYTGT}_y$ and $\mathbf{UYTGT}_y$ represent the amount over and under the desired target. Both of these deficiency variables are minimized in the objective function.

$$\sum_{r,c,a\le \text{Rcp}_r,t} X_{r,c,a,t,y} - OYTGT_y + UYTGT_y = \text{Enlisted}_y * \text{YTgt}_y \quad \forall y \ne YFIRST_y \qquad (5.7)$$

g) Involuntary Separation

Involuntary separation programs are commonly known as Programmed or Managed Losses (PML). Equation (5.8) limits the total PML for each rank and active federal service to a predetermined proportion of soldiers that survive normal attrition from the previous time period. The parameters **AfsPmlMn** and **AfsPmlMx** represent the minimum and maximum AFS required for PML consideration. The values used in the model are 3 years for a minimum and 17 years for a maximum. Although not defined during the course of my research, these values were chosen so as not to separate soldiers with little active duty experience or those that have reached the 18-year lock-in for retirement. The parameter **TigPmlMn** represents the desire not to involuntarily separate soldiers that have been recently promoted.

$$\sum_{c,t \ge \text{TigPmlMn}} PML_{r,c,a,t,y} \le \text{PmlRate}_{r,a} * \Big(\sum_{c,t \ge \text{TigPmlMn}} ((1 - \text{Att}_{r,a}\big|_{(r,c,y) \notin STOP_{r,c,y}}) * X_{r,c,a-1,t-1,y-1}) \quad (5.8)$$

$$+ \sum_{c,t \ge \text{TigPmlMn}} ((1 - \text{Att}_{r,a}\big|_{(r,c,y) \notin STOP_{r,c,y}}) * X_{r,c,a-1,t,y-1})\Big|_{t=\text{TigMax}_r} \Big)$$

$$\forall r, \text{AfsPmlMn} \le a \le \text{AfsPmlMx}, \text{y} \ne YFIRST_y$$

h) Yearly Accession Training Seat

Equation (5.9) limits the number of yearly accessions based on the available training seats in AGRET. As previously mentioned, the desired class size is 60 and 19 classes are scheduled for FY2002, making an upper bound of 1140 training seats per year. The set $\textbf{RCTR}_c$ defines CMF 79. The bound does not affect CMF 79, since they do not attend AGRET. The parameter $\textbf{Agret}_y$ is indexed by year, allowing an increase or decrease in training availability during the planning horizon.

$$\sum_{r \in RACC_r, c \ne RCTR_c, a \le \text{AfsAccMx}, t} ACC_{r,c,a,t,y} \le \text{Agret}_y \qquad \forall y \ne YFIRST_y \qquad (5.9)$$

i) Senior Enlisted

In Equation (5.10), the number of senior enlisted soldiers is limited based on the total end strength for each year of the planning horizon. The constraint applies only to those ranks that are elements of the set **SENIOR**$_r$, such as Master Sergeant and Sergeant Major. This constraint is necessary due congressionally mandated limits on senior sergeants.

$$\sum_{c,a \le \mathrm{Rcp}_r, t} X_{r,c,a,t,y} \le \mathrm{SenMax}_{r,y} \qquad \forall y \ne YFIRST_y, r \in SENIOR_r \tag{5.10}$$

j) Reclassification

Equation (5.11a) determines the eligibility requirements for reclassification. First, only ranks that are an element of the set **RRECL**$_r$ will be eligible for reclassification. Also, reclassification from rank r and CMF c in the current time period is limited to no more than the inventory available at the end of the previous time period. Additionally, a restriction on the TIG and AFS are imposed to ensure that newly promoted soldiers do not reclassify and that soldiers with very little or quite a lot of AFS are also denied reclassification. Equation (5.11b) ensures that for each rank and time period during the planning horizon, the sum of all outgoing reclassifications equals the sum of all incoming reclassifications.

$$\begin{aligned} RECLOUT_{r,c,a,t,y} \le {} & ((1 - \mathrm{Att}_{r,a}\big|_{(r,c,y) \notin STOP_{r,c,y}}) * X_{r,c,a-1,t-1,y-1}) \\ & + ((1 - \mathrm{Att}_{r,a}\big|_{(r,c,y) \notin STOP_{r,c,y}}) * X_{r,c,a-1,t,y-1})\big|_{t = \mathrm{TigMax}_r} \end{aligned} \tag{5.11a}$$

$\forall c, y \ne YFIRST_y, r \in RRECL_r, \mathrm{AfsReclMn} \le a \le \mathrm{AfsReclMx}, t \ge \mathrm{TigReclMn}$

$$\sum_{\substack{c,t \ge \mathrm{TigReclMn}, \\ \mathrm{AfsReclMn} \le a \le \mathrm{AfsReclMx}}} RECLOUT_{r,c,a,t,y} = \sum_{\substack{c,t \ge \mathrm{TigReclMn}, \\ \mathrm{AfsReclMn} \le a \le \mathrm{AfsReclMx}}} RECLIN_{r,c,a,t,y}$$

$\forall y \ne YFIRST_y, r \in RRECL_r$ (5.11b)

k) Stop-Loss

As mentioned earlier, a "stop loss" is implemented to stop the loss of critical job skills from the pool of available military manpower. Equation (5.12a) stops loss via reclassification and Equation (5.12b) stops loss via forced separation in rank r of CMF c during year y for all valid combinations of AFS and TIG. Losses due to attrition are stopped in the flow balance constraint (5.2).

$$RECLOUT_{r,c,a,t,y} \leq \text{StopLoss} \tag{5.12a}$$

$$\forall (r,c,y) \in STOP_{r.c,y}, y \neq YFIRST_y, \text{AfsReclMn} \leq a \leq \text{AfsReclMx}, t \geq \text{TigReclMn}$$

$$PML_{r,c,a,t,y} \leq \text{StopLoss} \tag{5.12b}$$

$$\forall \text{AfsPmlMn} \leq a \leq \text{AfsPmlMx}, t, y \neq YFIRST_y, (r,c,y) \in STOP_{r,c,y}$$

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VI. MODEL REFINEMENTS AND COMPUTATIONAL EXPERIENCE

This chapter describes some of the model refinements necessary to make the linear program introduced in the last chapter tractable. Without these techniques, the model could not be solved and would be of little value.

A. EMPM MODELING EVOLUTION

1. "Variable Time Step Model"

Initially, it was hoped to use a monthly time step throughout the model, but simple calculations predicted this would lead to an intractable model size. The "Variable Time Step Model" refers to the first model prototype developed to deal with this difficulty. The phrase "variable time step" refers to changing the amount of time represented by each index as the model progresses through the planning horizon. This model was developed to address the first year of the 7 year horizon on a monthly basis. The purpose was to address the man-year versus end strength mismatch which force the Full-Time Support Management Directorate (FTSMD) to decrease strength from the beginning of the fiscal year until some time in the 6 or 7th month and steadily increase strength thereafter until reaching the end strength objective at the end of the fiscal year.

The complex representation of time within the model made it necessary to develop two separate constraint structures. The first addressed the months of year one and the second handled all remaining years. Additionally, the variable time step caused data handling problems. For example, attrition rates for time periods m01 through m12 were required to be in months while attrition for all remaining time periods was in years. This problem was persistent across most of the data.

Due to the increase in size, the model was too large to solve on a 2.0 GHZ Pentium 4 PC with 1 gb RAM. After systematically reducing the number of CMFs from 27 to 20, the problem was solved in 326 hours. Since the model includes some randomization of accessions, the problem should be solved a number of times to achieve a high degree of confidence in the solution. Consequently, a decision was made to treat all periods as years to improve solution time. Monthly resolution, even for the first year only, was abandoned.

2. "Yearly Model"

The "Yearly Model" refers to the second model prototype. In this model, the time index is in years instead of months. The development of this model made it much easier for data handling and increased tractability. With the decrease in the size of the problem, solution times were improved greatly but still lagged behind expectations. On a 2.0 GHZ Pentium 4 PC with 1 gb RAM, the problem was solved in 4 hours. As mentioned earlier, due to randomization of accessions, the problem should be solved a number of times to achieve a high degree of confidence in the solution. Due to this fact, an analysis was undertaken to determine areas where speed could be increased without the loss of accuracy. Although not obvious at first, reduction in the TIG index appeared to provide the most promise.

3. "Yearly Model with Truncated Time in Grade"

Enlisted soldiers have no upper bound on the amount of TIG they may obtain in a particular rank. Since TIG is used only to determine promotion zone eligibility, truncating the TIG to the first full year of promotion eligibility in the PZ for each rank caused no loss of fidelity and a significant reduction in model size. The last year in the TIG index for each rank would denote the PZ for promotion. The inventory that reaches the PZ will only be aged thereon by years of AFS. We had previously modeled time in grade to 15 years. This change left the maximum TIG used for any rank no greater than 5 years. This dramatic reduction in the dimension of the problem decreased the number of variables and equations by more than a half. On a 2.0 GHZ Pentium 4 PC with 1 gb RAM, the problem was solved in approximately 30 minutes. This is the version of the model used for all analysis. Table 6.1 gives statistics on each model.

Model	Rows	Columns	Running Time
Variable Time Step	1,929,728	2,269,601	326 hrs
Yearly	468,595	872,535	4 hrs
Yearly with Truncated TIG	239,111	304,127	30 mins

Table 6.1 Model statistics

B. ACCESSION POOL DEVELOPMENT

In military manpower models, accession into the system normally takes place at the lowest ranks with no previous TIG or AFS. Since the AGR program is much different allowing accessions at most any TIG and AFS, I developed a technique known as an "accession pool". The accession pool is used to simulate the arrival process of potential AGR accessions. Since we never know exactly how many soldiers will apply for the AGR program, the volume of potential accessions for each year is generated by picking a uniform random number between some upper and lower bound. After determining the volume of the accession pool, random numbers are drawn and compared to historical distributions to develop the rank, CMF, TIG, and AFS of the accession pool. If the model needs an accession during a model run, it must select among the inventory in the accession pool. By constraining the number and type of accessions in this way, those soldiers entering the AGR program within the model are far more realistic.

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VII. IMPLEMENTATION AND ANALYSIS

A. MODEL IMPLEMENTATION

This section provides information about the data used in each scenario and demonstrates the usefulness of EMPM to military manpower planning.

1. Implementation

EMPM is implemented as a linear program on a personal computer equipped with a 2.0 GHZ Pentium 4 processor with a 1-gigabyte hard drive using GAMS Rev 117 (GAMS Development Corporation, 2001) with the CPLEX 6.6.1 (ILOG Corporation, 2002) solver. After experimentation with algorithm options, I chose to use the interior point or barrier algorithm. The results of each scenario are exported to Microsoft Excel 2000® (Microsoft Corporation, 1999) using a spreadsheet interface known as XLINK (Rutherford and Maliyev, 2002). With a typical model size of 239,000 equations and 304,000 variables, the problem solves in approximately 30 minutes.

2. Data

The data used in this thesis were collected from a number of different sources. FTSMD provided the current AGR enlisted inventory and structure as of December 2001. DMDC provided AGR enlisted personnel rosters from 1992 through 2001. These rosters were used to generate accession and attrition information used by the model. OCAR-RTD provided accession information on CMF 79. Most additional data were obtained by researching applicable regulations. The data files used in this analysis are contained in Appendices A (AGR Enlisted Inventory) and B (Other Data). Each scenario analyzed constitutes a small change in the model parameters. Unless specifically mentioned in the scenario description, the remaining data for the model remains constant throughout the analysis.

B. MODEL SCENARIOS AND ANALYSIS

I chose to address three scenarios of interest. The first couple of scenarios address the implementation of a stop loss. The last scenario is a change in AGR accession policy. The scenarios I selected for analysis are real world manpower issues that currently affect or may affect the AGR program in the future. EMPM incorporates the assumptions detailed in Chapter V across all scenarios.

1. Stop Loss Implementation

As mentioned earlier, a stop loss is normally implemented in times of war or national emergency to ensure the retention of critical skills in the force. Normally, a stop loss will retain soldiers in the inventory beyond their term of service or retirement. The stop loss may also ensure soldiers do not reclassify out of critical MOS and that they are not forcibly separated from the military. The specific guidelines of the stop loss implementation are developed by HQDA. While most stop loss actions are at the MOS level, this implementation will be at the CMF level. For the purpose of this thesis, a stop loss affects normal attrition, forced separation, and reclassifications out of the critical CMF.

a) Stop Loss Beginning in the Middle of a Planning Horizon

This scenario looks at starting a stop loss in the middle of the planning horizon (year 3) instead of having the stop loss in effect at the beginning of the planning horizon. The stop loss remains in effect for the remaining periods of the planning horizon. Those affected by the stop loss are CMF 63 (Mechanical Maintenance), CMF 71 (Administration), CMF 88 (Transportation), and CMF 92 (Supply and Services). The career management fields chosen in the stop loss scenario are important since they are some of the larger career fields. The ranks affected by the stop loss are Staff Sergeant and Sergeant First Class. For rank, CMF, and years (r,c,y) specified by the set $\boldsymbol{STOP_{r,c,y}}$, attrition, forced separation, and reclassification out of (r,c,y) are prevented by equations (5.2), (5.12a), and (5.12b).

The results of the scenario suggest that the implementation of the stop loss has an impact on end strength, force mix, accessions, and promotion rates. During the planning horizon, the average end strength deficit decreased by 2.86%. Table 7.1 demonstrates the effects of the stop loss on SSG and SFC inventory during the stop loss years. Since the SSG inventory was over-strength without the stop loss, the stop loss increased the deviation from the target by 3.22%. For SFC, since they were under-strength, the stop loss decreased the deviation from the target by 8.15%.

	SSG	SFC
Target	1766	5140
Average Inventory without Stop Loss	1841	4025
Average Deviation	4.25%	-21.69%
Average Inventory with Stop Loss	1898	4444
Average Deviation	7.47%	-13.54%

Table 7.1 Average inventory and average target deviation while stop loss is enforced during years 3 through 7

The promotion effects were also noticeable. Table 7.2 shows a comparison of the average promotion rates without and with the stop loss. There are two main causes for the drop in promotion rates to SSG through MSG. First, there are decreased promotion opportunities since fewer soldiers are leaving the inventory. Second, with fewer soldiers leaving the inventory, the pool of eligible soldiers increased. Without an offsetting increase in volume promotions, the promotion rate will automatically decrease.

RANK	WITHOUT STOP LOSS	WITH STOP LOSS	% DELTA
SSG	38.34%	33.83%	-4.51%
SFC	50.47%	46.89%	-3.58%
MSG	13.82%	11.66%	-2.16%

Table 7.2 Average promotion rate comparisons without and with stop loss

For most ranks, the stop loss reduced the rate of promotion and the volume of promotions. Figure 7.1 and 7.2 give a comparison of the overall promotion rates without and with the stop loss implementation.

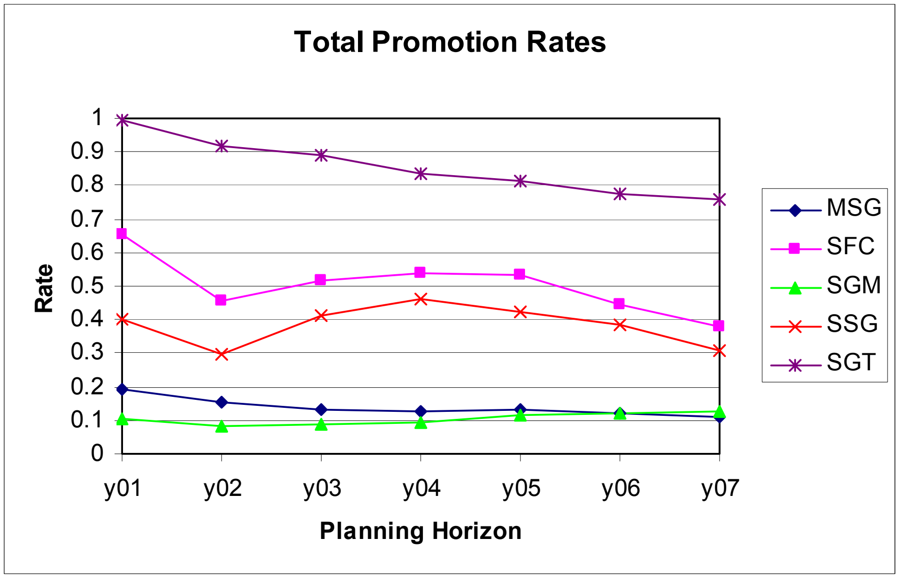

Figure 7.1 Promotion rates without the stop loss implementation

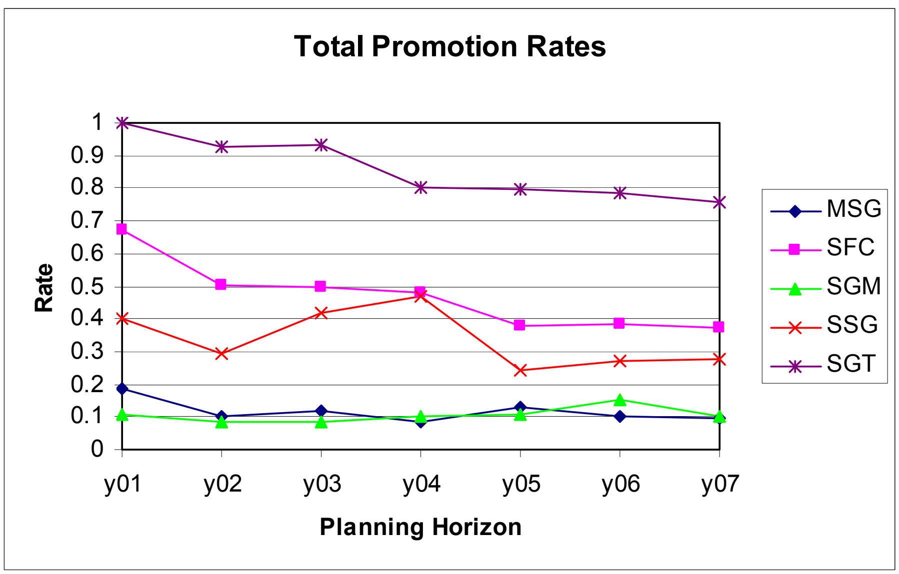

Figure 7.2 Promotion rates while stop loss is enforced during years 3 through 7

Since the inventory is not optimally distributed at the beginning of the planning horizon, the model promotes very high at the beginning to achieve a better force mix and reduce the deviation against the established strength targets. The promotion rates depicted in Figure 7.2 are noticeably lower with the largest reduction in time period 5. An analysis of promotion rates for time period 5 shows an 18% reduction in SSG promotions and a 15% reduction in SFC promotions.

To address the effects of the stop loss on a particular CMF, I would like to examine CMF 63. In CMF 63, the effects of the stop loss on promotion rates are far worse. Figure 7.3 and 7.4 give promotion rates within CMF 63 with and without the stop loss. Promotions during time period 5 dropped 24% for SFC and 19% for SSG. The adverse effects experienced by CMF 63 were felt by the other CMFs as well.

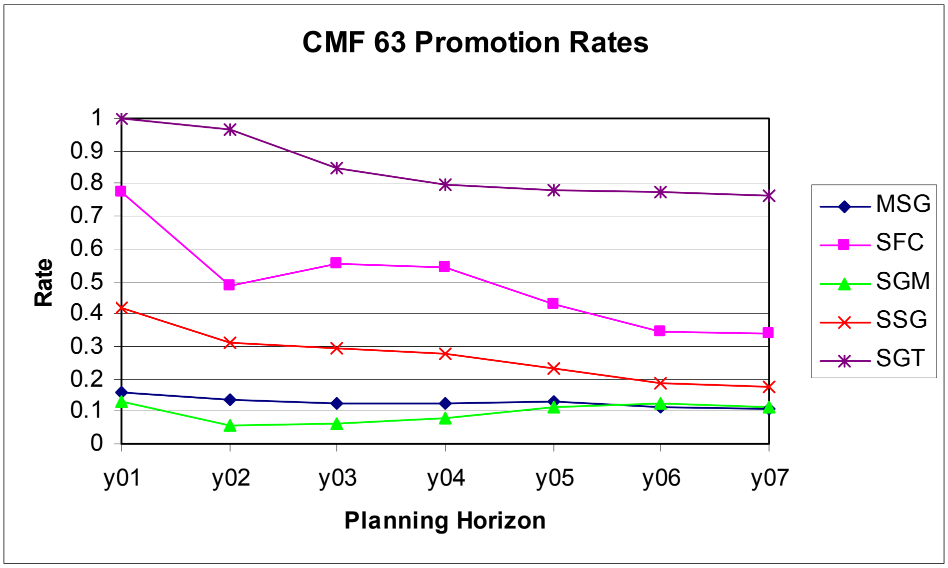

Figure 7.3 Promotion rates in CMF 63 without the stop loss implementation

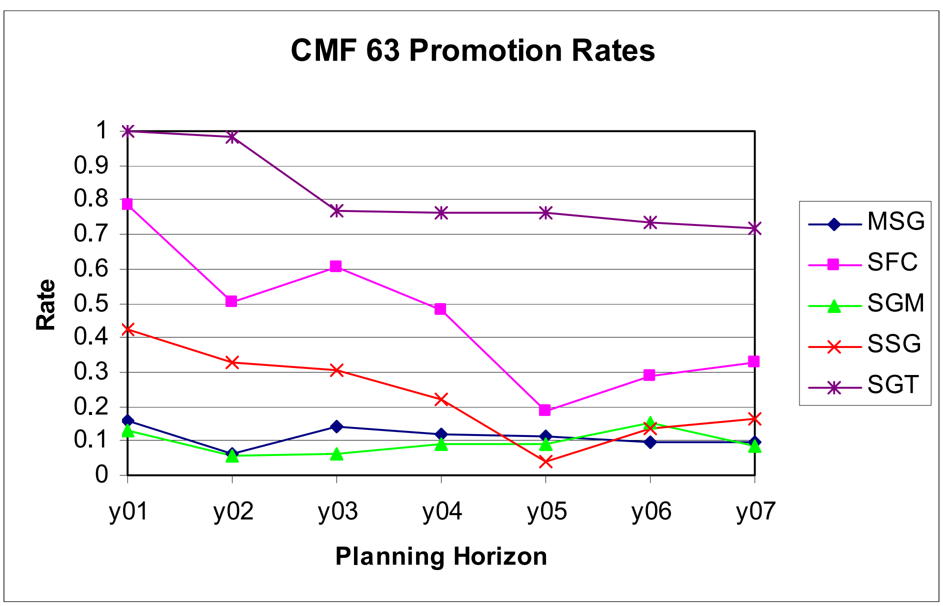

Figure 7.4 Promotion rates in CMF 63 while stop loss is enforced during years 3 through 7

The change in accessions was also very noticeable. Since fewer soldiers were leaving the inventory, demand for accessions dropped. On average, total accessions by the model decreased by 40 soldiers per year. This is a 4.2% reduction in accessions during the planning horizon.

As for reclassifications, there was above average reclassifications in time period two and well below average reclassifications in time period three through seven. As previously mentioned, there is no limit on the number of reclassifications the model may undertake. Due to the stop loss action, inventory that would have normally reclassified during time periods y03 through y07 instead reclassified during time period 2. In addition, no forced separations were undertaken with or without the stop loss.

b) Stop Loss in Effect at the Start of the Planning Horizon

The CMFs and all supporting data remain the same as in the previous scenario. Instead of starting the stop loss in time period three, the stop loss is in effect from time period one through time period three.

By being in a stop loss at the start of the planning horizon, the model reduces the end strength deficit quicker than in the previous scenario. During the planning horizon, the average end strength deficit decreased by 3.43%. Table 7.3 demonstrates the effects of the stop loss on SSG and SFC inventory during the stop loss years. While the SSG inventory was under-strength without the stop loss, the stop loss increased inventory to 8.38% over the target strength. This scenario caused a much larger average deviation to the SSG strength target than in the previous scenario. Since SFC was under-strength, the stop loss decreased the deviation from the target by 6.66%.

	SSG	SFC
Target	1766	5140
Average Inventory without Stop Loss	1757	3702
Average Deviation	-0.51%	-27.98%
Average Inventory with Stop Loss	1914	4044
Average Deviation	8.38%	-21.32%

Table 7.3 Average inventory and average target deviation while the stop loss is enforced during years 1 through 3

RANK	WITHOUT STOP LOSS	WITH STOP LOSS	% DELTA
SSG	38.34%	35.24%	-3.10%
SFC	50.47%	46.04%	-4.43%
MSG	13.82%	12.81%	-1.01%

Table 7.4 Average promotion rate comparison while the stop loss is enforced during years 1 through 3

Table 7.4 shows a comparison of the average promotion rates with and without the stop loss during time period y01 through y03. Where the previous scenario affected SSG promotion rates more than SFC, the opposite is true in this scenario.

Figure 7.5 displays the effects of this stop loss scenario on CMF 63. Table 7.5 shows the deviation from the scenario without a stop loss for CMF 63. During years 1 through 3, the effects are rather dramatic showing a serious reduction in the rate of promotions to SGT through SFC. The promotion rates increase in years 4 through 7 after the stop loss has ended.

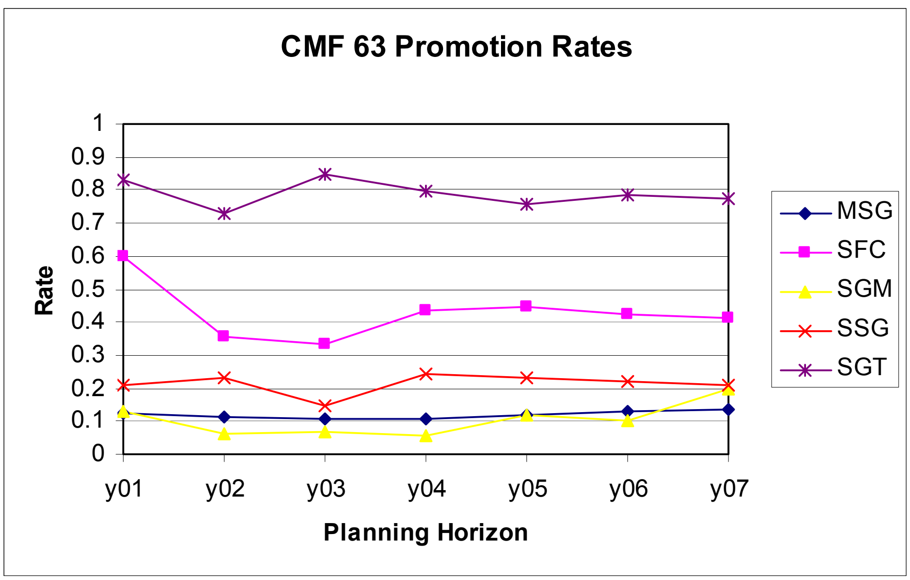

Figure 7.5 Promotion rates in CMF 63 while the stop loss is enforced during years 1 through 3

	y01	y02	y03	y04	y05	y06	y07
SGT	-16.74%	-25.33%	7.72%	2.99%	-0.73%	5.17%	5.85%
SSG	-21.23%	-9.53%	-16.13%	2.54%	18.82%	8.33%	4.20%
SFC	-18.61%	-14.58%	-27.22%	-4.57%	26.02%	13.42%	8.05%
MSG	-3.51%	5.49%	-3.80%	-1.04%	0.75%	3.45%	3.69%
SGM	0.00%	0.25%	0.81%	-3.46%	2.77%	-5.02%	11.66%

Table 7.5 Promotion rate deviations from scenario without a stop loss

The change in accessions was also very noticeable. On average, total accessions by the model decreased by 17 soldiers per year. During the stop loss years, the average number of accessions dropped by 30 soldiers per year. For the entire planning horizon, there was a 1.7% reduction in accessions.

The reclassifications undertaken by the model during the entire planning horizon were similar to those without a stop loss. The only noticeable difference was that reclassifications during the stop loss were lower. This result was much different than the large increase in reclassifications experienced in time period two with the previous scenario. Figure 7.6 and 7.7 displays the inventory position for SFC and SSG during each period of the planning horizon without the stop loss and for both scenarios.

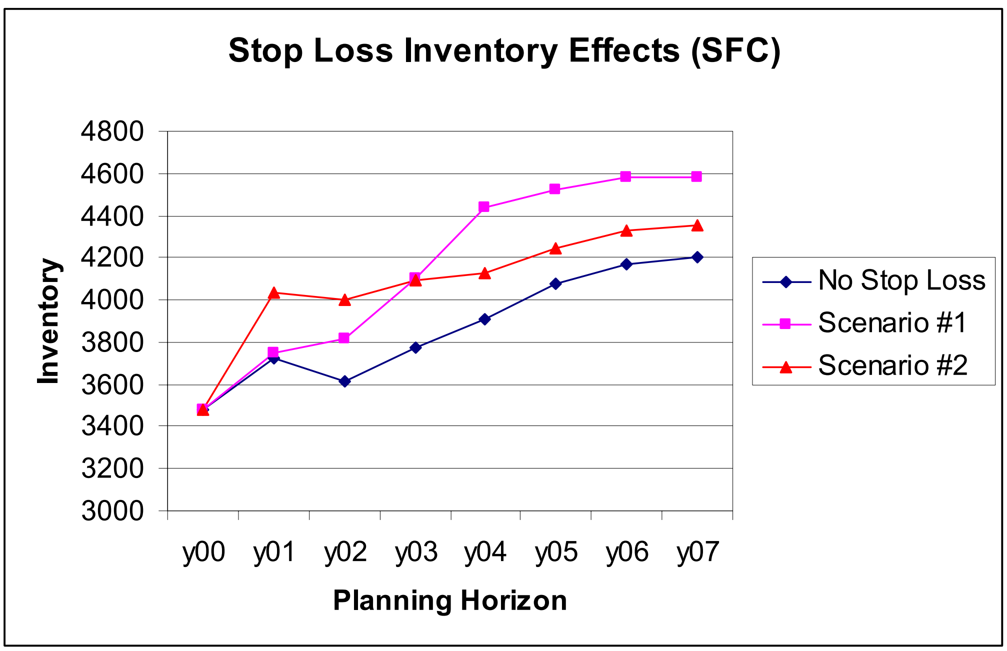

Figure 7.6 Stop loss inventory effects comparison for SFC

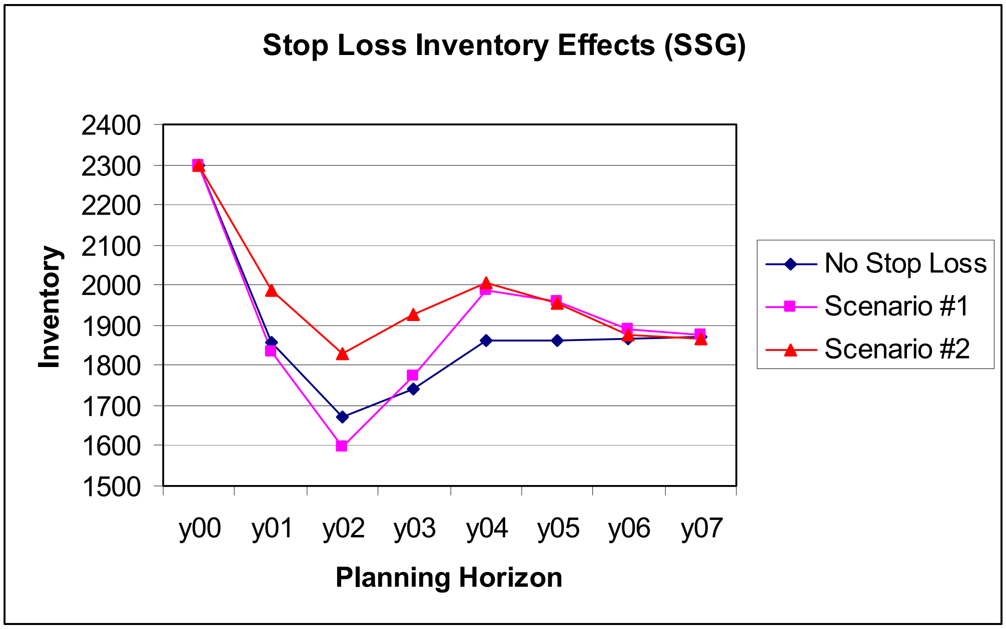

Figure 7.7 Stop loss inventory effects comparison for SSG

2. Accession Policy Adjustments

The Chief, Army Reserve made the decision to allow accession of Master Sergeants into the AGR program for FY2002. This scenario looks at the effects of a change in the accession policy to allow hiring of Master Sergeants into the AGR program. To analyze this course of action, changes were made to the distribution to allow Master Sergeant accession availability to the model and Master Sergeants were added to the set of authorized accession ranks. The adjusted distribution is shown at Table 7.6.

RANK	CDF
SL1	0.250
SGT	0.500
SSG	0.750
SFC	0.875
MSG	1.000

Table 7.6 Adjusted cumulative distributions for accessions

Table 7.7 gives a numerical example of the underlying changes experienced by the inventory. This increase in the SFC and SSG inventory can be explained due to the decrease in the overall promotions and the change in the distribution for accessions. In most cases, the model accessed MSG personnel to meet the requirement rather than promoting from a lower grade.

	No MSG Accessions	With MSG Accessions
SL1	342	305
SGT	1297	1241
SSG	1879	1886
SFC	3867	3974
MSG	1066	1070
SGM	135	135

Table 7.7 Average enlisted inventory without and with MSG accessions

Although all ranks experienced a decrease in promotions due to MSG accessions, the largest effect was on MSG and SGM promotion rates. The dramatic decreases in rates of promotion to MSG (-40.44%) and SGM (-25.11%) are included Table 7.8.

RANK	NO MSG	MSG	% DELTA
SGT	85.45%	81.37%	-4.77%
SSG	38.34%	34.64%	-9.64%
SFC	50.47%	43.83%	-13.15%
MSG	13.82%	8.23%	-40.44%
SGM	10.49%	7.83%	-25.41%

Table 7.8 Enlisted promotion rates without and with MSG accessions

The average total number of accessions for the scenario increased by almost 50 when compared to the scenario without MSG accessions. The increase in accessions can be attributed to the adjustment in the accessioning rank distribution. Apparently, this adjustment was a positive change since average accessions increased during the scenario. The analysis of the reclassifications shows an average increase of over 25. Ironically, average enlisted inventory also increased by approximately 25 soldiers. Conclusions from these analyses are given in the next and final chapter.

C. SENSITIVITY ANALYSIS

The results of the model runs are based on the input data and the assumptions that guide the model. If any of those assumptions are changed, the results will change. Some of those assumptions were penalties associated with CMF target strength, yearly end strength, reclassifications, and forced separation. The value of a penalty has an influence on the outcome of a scenario. In this section, I will conduct a sensitivity analysis of penalties associated with reclassification, CMF target strength, and yearly target in the model.

1. Reclassification Penalty

With all other penalties held constant and the accession pool fixed at 1211, the penalty for reclassification was systematically reduced from 40 to 2. The penalty reduction resulted in increased reclassifications and improvement in achieving the end strength objective. Promotion rates to SGT, MSG, and SGM improved slightly while those to SSG declined by 10% and SFC by 15%. In most cases, the number of accessions increased as the penalty declined. This result suggests that the model is accessing many soldiers with the express intent to reclassify them in the next or future periods. The reclassifications undertaken by the model as the penalty becomes very small are in most cases unrealistic. For example, in year 4 with the penalty equal to 2, the model undertakes 906 reclassifications. The 906 reclassifications represent approximately 10% of the entire enlisted force. Since the AGR program has serious budgetary restrictions, this figure is much too high. Before setting this penalty, intensive analysis must be conducted to determine a realistic number of reclassifications that are appropriate during the planning horizon based on the budgetary restrictions. I have included Figures 7.8, 7.9, and 7.10 showing inventory, accession, and reclassification effects.

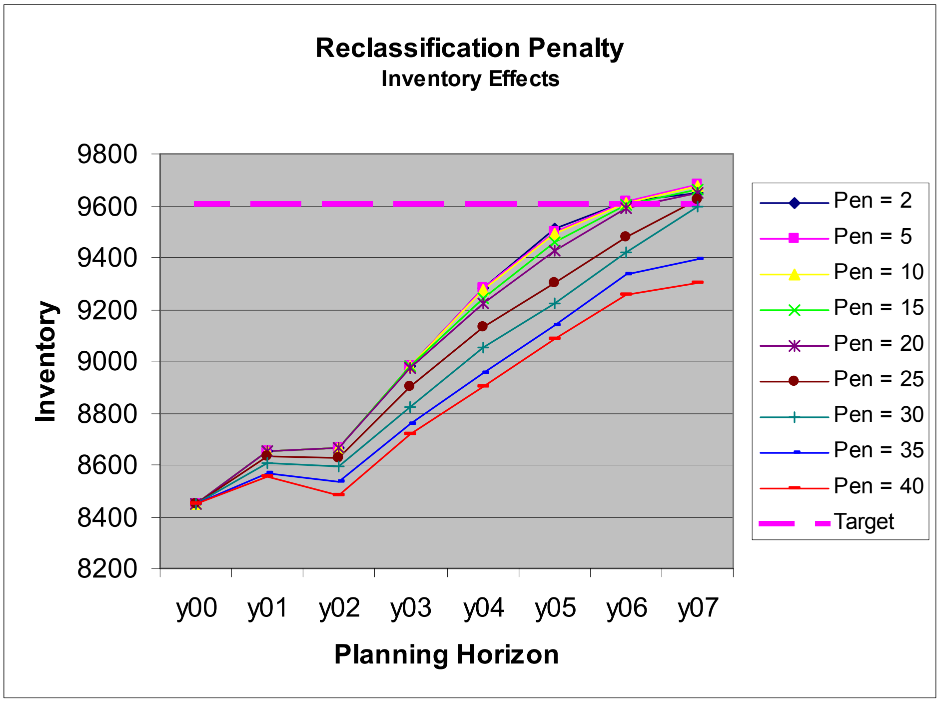

Figure 7.8 Reclassification penalty inventory effects

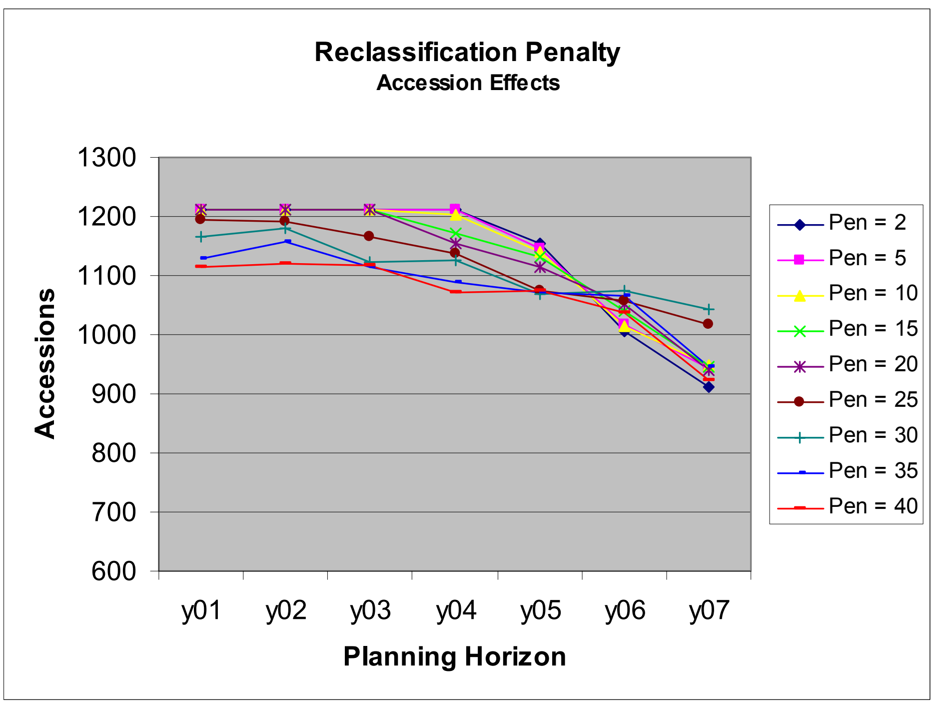

Figure 7.9 Reclassification penalty accession effects

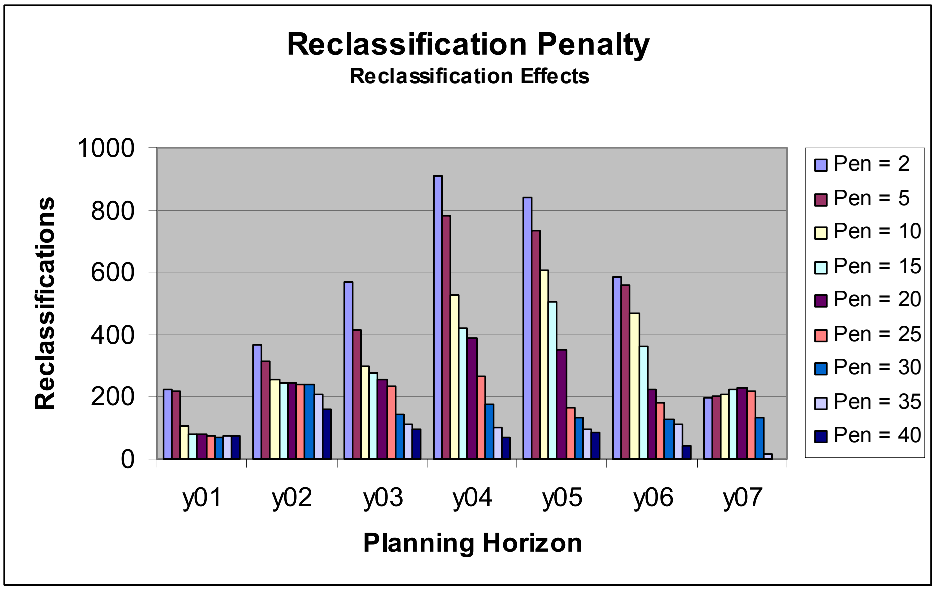

Figure 7.10 Reclassification penalty reclassification effects

2. Over CMF Target Strength Penalty

With all other penalties held constant and the accession pool fixed at 1211. The penalty for exceeding the CMF target strength was systematically decreased from 20 to 5. The results of the decrease showed an improvement in achieving the end strength objective and resulted in fewer reclassifications in years 2 and 3 but higher reclassifications in years 4 through 7. The analysis suggests that increasing reclassifications developed a better force mix in years 4 through 7 and therefore, reduced the objective function value. In addition, the model accessed more soldiers into the AGR program when the penalty was low. Since there was very little penalty, the model accessed soldiers that it may not need in a certain CMF just to make the end strength objective. I have included Figures 7.11 and 7.12 showing inventory and reclassification effects.

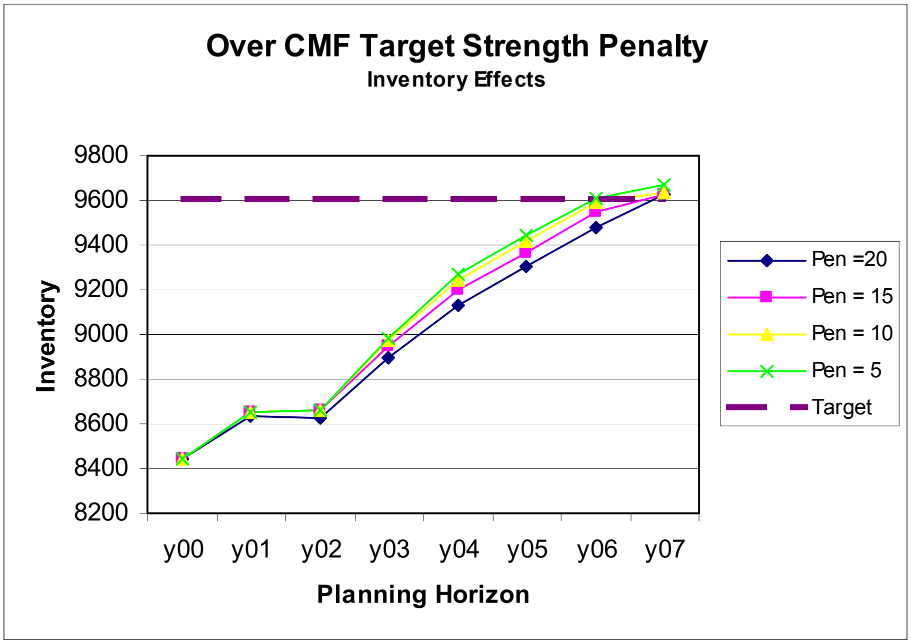

Figure 7.11 Over CMF target strength penalty inventory effects

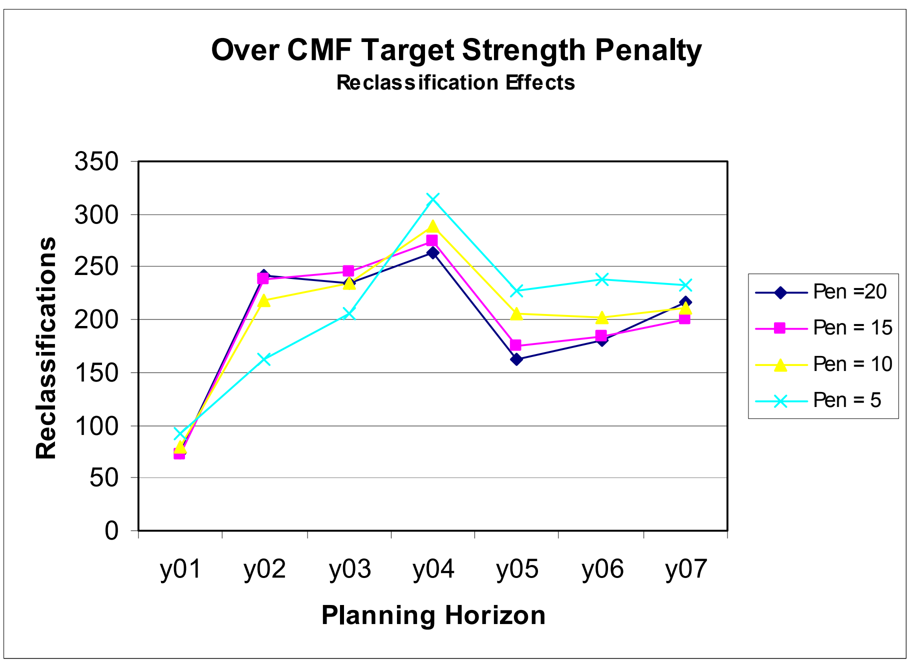

Figure 7.12 Over CMF target strength penalty reclassification effects

3. Under CMF Target Strength Penalty

With all other penalties held constant and the accession pool fixed at 1211. The penalty for underachieving the CMF target strength was systematically reduced from 20 to 5. Increasing the penalty improved end strength accomplishment. Figure 7.13 demonstrates the effects of the penalty reduction.

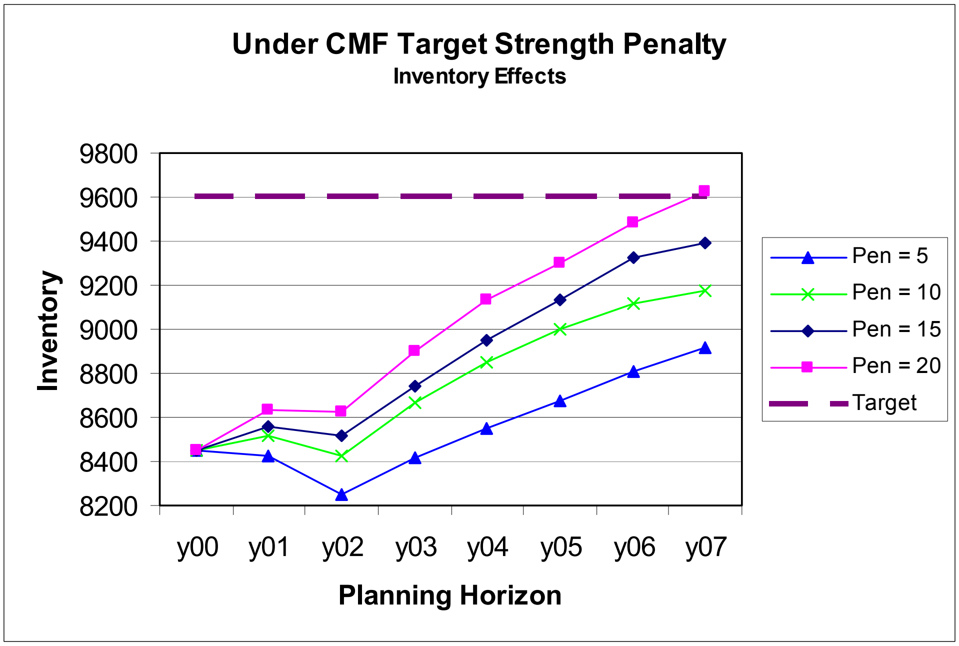

Figure 7.13 Under CMF target strength penalty inventory effects

4. Yearly Target Strength Penalty

With all other penalties held constant and the accession pool fixed at 1211. The penalty for not meeting the yearly target strength was systematically increased in various steps from 2 until reaching 40. The results of the increase changed little after the penalty increased beyond 20. The results of the model runs demonstrate that the penalty has little effect on overall promotion rates but does influence total accessions.

I have included two figures that demonstrate the effects of the penalty adjustment. Figure 7.14 shows the inventory effects and Figure 7.15 shows the accession effects. As the penalty increases, the inventory continues to increase until reaching the target strength in time period 5. When the inventory reaches the end strength target in time period 5, accessions become less important. Based on this analysis, the availability of accessions is the major hindrance to overall accomplishment of the end strength objective in time periods 1 through 4.

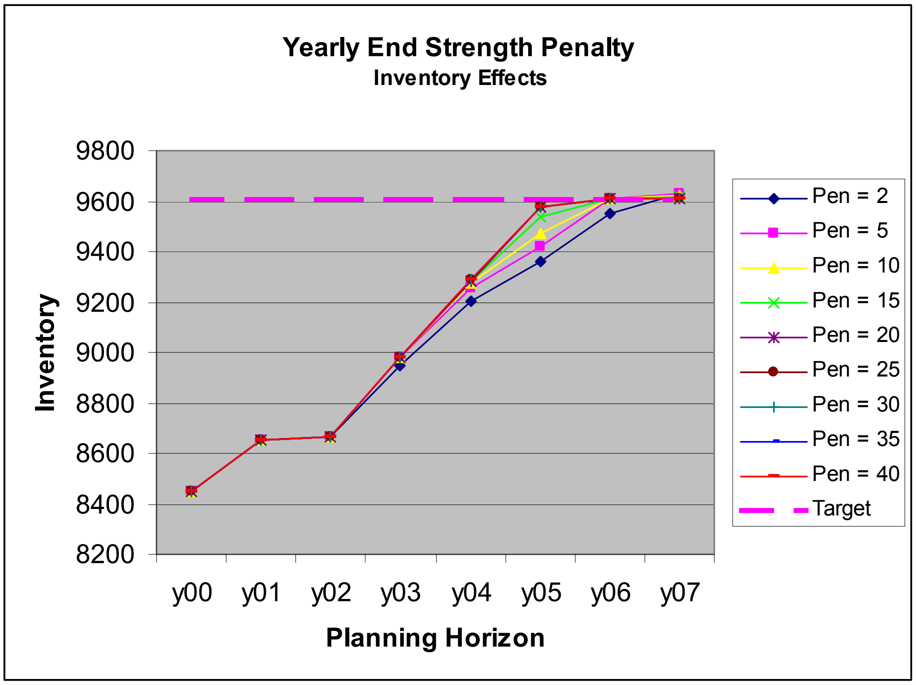

Figure 7.14 Yearly end strength penalty inventory effects

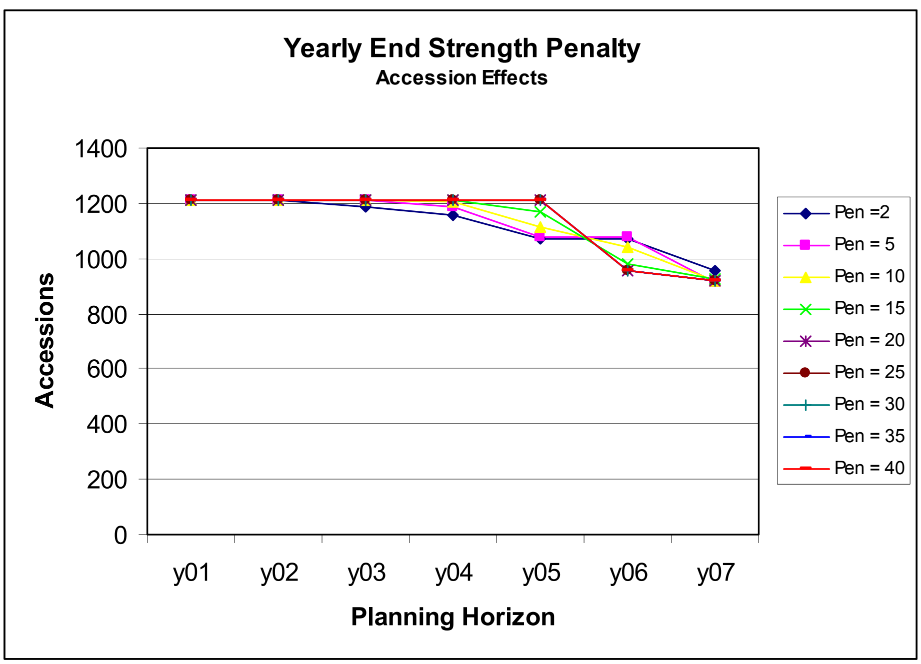

Figure 7.15 Yearly end strength penalty accession effects

VIII. CONCLUSIONS AND RECOMMENDATIONS

To assist OCAR-PAE in analysis of the AGR enlisted force, this thesis develops an optimization model known as the AGR Enlisted Manpower Projection Model (AGR-EMPM). The primary purpose of the model is as a manpower forecasting and decision analysis tool. With a 7-year planning horizon, the model aggregates at the CMF level by rank, active federal service, and time in grade. The decisions addressed by the model include promotions, forced separations, and reclassifications. The model is flexible and can be used to analyze various manpower issues.

To demonstrate the usefulness of the model, three scenarios were analyzed. The first two scenarios analyzed implementation of stop loss on various career management fields and ranks.

The first scenario addressed a stop loss action during years 3 through 7. During the stop loss period, the overall promotion rates to SFC declined by 15% while SSGs declined by 19%. Promotion rates within CMF 63 declined as much as 24% to SFC and 19% to SSG during the period of the stop loss. Accessions during the planning horizon decreased by 4.2%.

The second scenario addressed a stop loss action during years 1 through 3. The results of the second scenario were much the same as those in the first scenario. There were deep declines in the overall promotion rates with far greater reductions in the affected CMFs. During the stop loss period, promotion rates declined as much as 27% to SFC and 21% to SSG. Accessions during the planning horizon declined 1.7%.

The results of the analysis suggest that implementing a stop loss, whether for a long or short duration, affects promotion rates and accessions. The decrease in the need for accessions may be good, however, a reduction in promotion rates may reduce morale. Should a stop loss be directed by HQDA, I recommend that intensive analysis be conducted to determine the global effects on inventory, accessions, and promotions within each rank and CMF before implementation.

The third scenario analyzed the Chief, Army Reserve's recent decision to access Master Sergeants into the AGR program. The results of the analysis suggest that the accession of MSGs into the AGR program has the potential for serious long-term effects to promotion rates. The most heavily affected were MSG (-40.44%) and SGM (-25.41%). While average enlisted inventory and accessions increased, the promotion rates for every rank decreased. This outcome suggests that great care must be taken not to over access Master Sergeants into the inventory and thereby seriously reduce long-term promotion rates.

The research, formulation, and implementation of this model have led to many areas for future research. The following is a list that I have compiled during the course of this project.

1. Expansion of the model to address officers and warrant officers. The enlisted and officer models would be separate except for linkage via a link in budgetary constraints.
2. Analysis to determine the optimal accession mix.
3. Analysis of effects of adjustments to retention control points.
4. Fixing accessions in the first year to no more than those currently waiting on the AGR order of merit list and simulating accessions for year 2 through 7.
5. Analysis of changes to the primary and secondary promotion zones.
6. Determination of force structure requirements for years 2 through 7 instead of assuming constant force structure.

APPENDIX A. AGR ENLISTED INVENTORY

	Time in Grade		
AFS	≤ 01	02	03 ≤
01	2	5	19
02	4	11	10
03	3	7	25
04	1	11	28
05	1	7	22
06	0	3	18
07	0	1	12
08	1	1	13
09	0	0	7
10	0	0	5
11	0	0	4
12	1	0	5
13	0	1	5
14	0	0	2
15	0	0	5
16	0	0	1
17	1	1	2
18	0	0	2
19	0	1	3

Table A.1 Skill Level 1 inventory at the end of December 2001

	Time in Grade		
AFS	**≤ 01**	**02**	**03 ≤**
01	22	15	16
02	16	31	27
03	19	92	91
04	15	15	72
05	15	18	62
06	15	22	47
07	6	13	51
08	7	13	54
09	7	19	70
10	11	14	52
11	4	10	48
12	7	3	54
13	3	11	61
14	2	6	42
15	3	6	37
16	1	3	36
17	0	1	32
18	0	4	19
19	3	2	39

Table A.2 Sergeant inventory at the end of December 2001

	Time in Grade			
AFS	**≤ 01**	**02**	**03**	**04≤**
01	4	6	2	4
02	9	8	7	15
03	54	44	29	60
04	44	27	9	30
05	36	32	9	19
06	39	53	21	22
07	26	31	19	24
08	21	48	21	28
09	27	63	20	27
10	37	36	22	28
11	31	46	14	31
12	31	58	19	42
13	36	51	31	50
14	19	47	22	64
15	19	40	17	56
16	16	39	25	56
17	21	21	21	45
18	8	26	14	36
19	22	29	23	112

Table A.3 Staff Sergeant inventory at the end of December 2001

	Time in Grade				
AFS	**≤ 01**	**02**	**03**	**04**	**05≤**
01	2	0	1	8	3
02	2	1	2	2	4
03	79	49	9	25	17
04	17	21	7	5	10
05	12	13	9	5	15
06	15	6	10	8	16
07	17	8	17	8	26
08	12	14	14	3	14
09	22	24	23	9	20
10	37	21	25	11	22
11	46	27	33	16	35
12	38	36	31	31	37
13	50	32	35	16	61
14	54	25	53	29	81
15	43	32	61	26	96
16	27	21	60	30	104
17	30	22	62	38	149
18	25	18	60	27	165
19	26	7	49	27	210
20	13	11	42	26	205
21	0	6	29	15	234

Table A.4 Sergeant First Class inventory at the end of December 2001

	Time in Grade				
AFS	**≤ 01**	**02**	**03**	**04**	**05≤**
01	0	0	0	0	0
02	0	0	0	0	0
03	0	0	0	0	0
04	0	0	0	0	0
05	0	2	0	0	0
06	1	0	0	0	0
07	2	0	0	0	1
08	1	2	0	0	0
09	1	3	1	0	0
10	5	3	0	0	1
11	1	3	0	0	0
12	4	8	5	2	1
13	10	18	3	3	4
14	6	10	3	1	1
15	11	11	8	7	3
16	17	16	7	3	16
17	21	36	13	10	18
18	26	40	12	11	21
19	29	34	12	11	22
20	21	30	28	15	58
21	15	25	14	7	43
22	8	17	8	6	39
23	0	4	10	10	45

Table A.5 Master Sergeant inventory at the end of December 2001

	Time in Grade	
AFS	**≤01**	**2≤**
01	0	0
02	0	0
03	0	0
04	0	0
05	0	0
06	0	0
07	0	0
08	0	0
09	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	0	0
15	1	2
16	3	3
17	2	2
18	3	8
19	3	13
20	6	16
21	1	11
22	5	17
23	2	8
24	2	6
25	0	13

Table A.6 Sergeant Major inventory at the end of December 2001

APPENDIX B. OTHER DATA

	Active Federal Service																									
RANK	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
SL1	0.06	0.06	0.10	0.11	0.14	0.08	0.11	0.05	0.14	0.13	0.14	0.19	0.22	0.33	0.33	0.33	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SGT	0.06	0.06	0.08	0.08	0.08	0.09	0.08	0.09	0.08	0.08	0.05	0.07	0.07	0.05	0.07	0.09	0.05	0.11	0.16	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SSG	0.07	0.05	0.11	0.09	0.07	0.07	0.05	0.05	0.05	0.06	0.06	0.05	0.04	0.05	0.04	0.06	0.05	0.08	0.22	0.80	1.00	1.00	1.00	1.00	1.00	1.00
SFC	0.14	0.10	0.07	0.06	0.06	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.04	0.05	0.07	0.06	0.06	0.07	0.18	0.46	0.48	1.00	1.00	1.00	1.00	1.00
MSG	0.14	0.10	0.07	0.06	0.06	0.03	0.06	0.09	0.04	0.02	0.02	0.06	0.05	0.05	0.05	0.07	0.07	0.09	0.13	0.38	0.34	0.31	0.43	1.00	1.00	1.00
SGM	0.14	0.10	0.07	0.06	0.06	0.03	0.06	0.09	0.04	0.02	0.02	0.06	0.03	0.02	0.02	0.07	0.06	0.10	0.11	0.23	0.27	0.35	0.19	0.50	0.25	1.00

Table B.1 Derived Attrition Rates by Rank and years of Active Federal Service

	Time in Grade												
RANK	1	2	3	4	5	6	7	8	9	10	11	12	13
SL1	0.08	0.25	0.40	0.52	0.62	0.71	0.78	0.84	0.90	0.94	0.96	0.98	0.99
SGT	0.09	0.26	0.42	0.53	0.62	0.70	0.76	0.82	0.88	0.91	0.93	0.96	0.97
SSG	0.09	0.27	0.43	0.58	0.68	0.77	0.83	0.88	0.91	0.93	0.94	0.96	0.97
SFC	0.08	0.24	0.34	0.45	0.51	0.62	0.68	0.73	0.78	0.82	0.85	0.88	0.90
MSG	0.16	0.28	0.42	0.51	0.62	0.68	0.73	0.73	0.77	0.80	0.86	0.94	0.94

Table B.2 Time in Grade Marginal Values for Accession

	Active Federal Service												
RANK	1	2	3	4	5	6	7	8	9	10	11	12	13
SL1	0.40	0.52	0.59	0.73	0.79	0.84	0.87	0.92	0.96	0.97	0.99	0.99	1.00
SGT	0.15	0.26	0.32	0.41	0.50	0.62	0.68	0.76	0.82	0.86	0.90	0.94	0.97
SSG	0.08	0.17	0.23	0.32	0.40	0.46	0.51	0.61	0.66	0.72	0.78	0.84	0.89
SFC	0.03	0.10	0.14	0.20	0.25	0.28	0.33	0.36	0.41	0.45	0.50	0.56	0.62
MSG	0.03	0.10	0.14	0.20	0.25	0.28	0.33	0.36	0.41	0.45	0.50	0.56	0.62

Table B.3 Active Federal Service Marginal Values for Accession

		Planning Horizon						
RANK	CMF	y01	y02	y03	y04	y05	y06	y07
SGT	11	2	2	2	2	2	2	2
SSG	11	42	42	42	42	42	42	42
SFC	11	73	73	73	73	73	73	73
MSG	11	44	44	44	44	44	44	44
SGM	11	7	7	7	7	7	7	7
SGT	12	1	1	1	1	1	1	1
SSG	12	1	1	1	1	1	1	1
SFC	12	41	41	41	41	41	41	41
MSG	12	9	9	9	9	9	9	9
SGM	12	2	2	2	2	2	2	2
SGT	13	0	0	0	0	0	0	0
SSG	13	0	0	0	0	0	0	0
SFC	13	2	2	2	2	2	2	2
MSG	13	1	1	1	1	1	1	1
SGM	13	0	0	0	0	0	0	0
SGT	19	0	0	0	0	0	0	0
SSG	19	0	0	0	0	0	0	0
SFC	19	8	8	8	8	8	8	8
MSG	19	3	3	3	3	3	3	3
SGM	19	0	0	0	0	0	0	0
SGT	25	0	0	0	0	0	0	0
SSG	25	1	1	1	1	1	1	1
SFC	25	1	1	1	1	1	1	1
MSG	25	0	0	0	0	0	0	0
SGM	25	0	0	0	0	0	0	0
SGT	31	7	7	7	7	7	7	7
SSG	31	19	19	19	19	19	19	19
SFC	31	41	41	41	41	41	41	41
MSG	31	14	14	14	14	14	14	14
SGM	31	2	2	2	2	2	2	2
SGT	35	2	2	2	2	2	2	2
SSG	35	3	3	3	3	3	3	3
SFC	35	5	5	5	5	5	5	5
MSG	35	0	0	0	0	0	0	0
SGM	35	0	0	0	0	0	0	0
SGT	37	2	2	2	2	2	2	2
SSG	37	4	4	4	4	4	4	4
SFC	37	27	27	27	27	27	27	27
MSG	37	10	10	10	10	10	10	10
SGM	37	2	2	2	2	2	2	2
SGT	38	4	4	4	4	4	4	4
SSG	38	28	28	28	28	28	28	28
SFC	38	21	21	21	21	21	21	21
MSG	38	18	18	18	18	18	18	18
SGM	38	2	2	2	2	2	2	2
SGT	46	0	0	0	0	0	0	0
SSG	46	1	1	1	1	1	1	1
SFC	46	30	30	30	30	30	30	30
MSG	46	5	5	5	5	5	5	5
SGM	46	1	1	1	1	1	1	1

Table B.4 AGR Force Structure in CMF 11 thru 46

		Planning Horizon						
RANK	CMF	y01	y02	y03	y04	y05	y06	y07
SGT	51	3	3	3	3	3	3	3
SSG	51	19	19	19	19	19	19	19
SFC	51	102	102	102	102	102	102	102
MSG	51	28	28	28	28	28	28	28
SGM	51	5	5	5	5	5	5	5
SGT	54	1	1	1	1	1	1	1
SSG	54	11	11	11	11	11	11	11
SFC	54	41	41	41	41	41	41	41
MSG	54	14	14	14	14	14	14	14
SGM	54	3	3	3	3	3	3	3
SGT	55	0	0	0	0	0	0	0
SSG	55	8	8	8	8	8	8	8
SFC	55	21	21	21	21	21	21	21
MSG	55	3	3	3	3	3	3	3
SGM	55	0	0	0	0	0	0	0
SGT	63	394	394	394	394	394	394	394
SSG	63	262	262	262	262	262	262	262
SFC	63	543	543	543	543	543	543	543
MSG	63	120	120	120	120	120	120	120
SGM	63	10	10	10	10	10	10	10
SGT	67	10	10	10	10	10	10	10
SSG	67	4	4	4	4	4	4	4
SFC	67	13	13	13	13	13	13	13
MSG	67	1	1	1	1	1	1	1
SGM	67	0	0	0	0	0	0	0
SGT	71	624	624	624	624	624	624	624
SSG	71	411	411	411	411	411	411	411
SFC	71	1151	1151	1151	1151	1151	1151	1151
MSG	71	251	251	251	251	251	251	251
SGM	71	34	34	34	34	34	34	34
SGT	74	4	4	4	4	4	4	4
SSG	74	26	26	26	26	26	26	26
SFC	74	83	83	83	83	83	83	83
MSG	74	26	26	26	26	26	26	26
SGM	74	3	3	3	3	3	3	3
SGT	77	0	0	0	0	0	0	0
SSG	77	15	15	15	15	15	15	15
SFC	77	102	102	102	102	102	102	102
MSG	77	14	14	14	14	14	14	14
SGM	77	1	1	1	1	1	1	1
SGT	79	0	0	0	0	0	0	0
SSG	79	0	0	0	0	0	0	0
SFC	79	1843	1843	1843	1843	1843	1843	1843
MSG	79	280	280	280	280	280	280	280
SGM	79	21	21	21	21	21	21	21
SGT	81	0	0	0	0	0	0	0
SSG	81	2	2	2	2	2	2	2
SFC	81	3	3	3	3	3	3	3
MSG	81	0	0	0	0	0	0	0
SGM	81	0	0	0	0	0	0	0

Table B.5 AGR Force Structure in CMF 51 thru 81

		Planning Horizon						
RANK	CMF	y01	y02	y03	y04	y05	y06	y07
SGT	88	22	22	22	22	22	22	22
SSG	88	64	64	64	64	64	64	64
SFC	88	175	175	175	175	175	175	175
MSG	88	40	40	40	40	40	40	40
SGM	88	7	7	7	7	7	7	7
SGT	91	30	30	30	30	30	30	30
SSG	91	57	57	57	57	57	57	57
SFC	91	184	184	184	184	184	184	184
MSG	91	48	48	48	48	48	48	48
SGM	91	9	9	9	9	9	9	9
SGT	92	359	359	359	359	359	359	359
SSG	92	752	752	752	752	752	752	752
SFC	92	530	530	530	530	530	530	530
MSG	92	124	124	124	124	124	124	124
SGM	92	15	15	15	15	15	15	15
SGT	93	1	1	1	1	1	1	1
SSG	93	5	5	5	5	5	5	5
SFC	93	3	3	3	3	3	3	3
MSG	93	6	6	6	6	6	6	6
SGM	93	1	1	1	1	1	1	1
SGT	95	0	0	0	0	0	0	0
SSG	95	16	16	16	16	16	16	16
SFC	95	62	62	62	62	62	62	62
MSG	95	19	19	19	19	19	19	19
SGM	95	9	9	9	9	9	9	9
SGT	96	2	2	2	2	2	2	2
SSG	96	14	14	14	14	14	14	14
SFC	96	31	31	31	31	31	31	31
MSG	96	19	19	19	19	19	19	19
SGM	96	2	2	2	2	2	2	2
SGT	98	1	1	1	1	1	1	1
SSG	98	1	1	1	1	1	1	1
SFC	98	4	4	4	4	4	4	4
MSG	98	4	4	4	4	4	4	4
SGM	98	0	0	0	0	0	0	0

Table B.6 AGR Force Structure in CMF 88 thru 98

CMF	CDF
11	0.028
12	0.037
13	0.049
19	0.059
25	0.062
31	0.078
35	0.081
37	0.084
38	0.093
46	0.095
51	0.126
54	0.140
55	0.151
63	0.249
67	0.255
71	0.447
74	0.455
77	0.484
79	0.668
81	0.669
88	0.731
91	0.807
92	0.963
93	0.969
95	0.991
96	0.998
98	1.000

Table B.7 CMF Cumulative Distribution Function for Accessions

RANK	CDF
SL1	0.312
SGT	0.604
SSG	0.863
SFC	0.983
MSG	1.000

Table B.8 Rank Cumulative Distribution Function for Accessions

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APPENDIX C. CAREER MANAGEMENT FIELDS

CAREER MANAGEMENT FIELD	DESCRIPTION
11	Infantry
12	Combat Engineering
13	Field Artillery
14	Air Defense Artillery
18	Special Forces
19	Armor
25	Visual Information
31	Signal Operations
33	Electronic Warfare/Intercept Systems Maintenance
35	Electronic Maintenance and Calibration
37	Psychological Operations
38	Civil Affairs
46	Public Affairs
51	General Engineering
54	Chemical
55	Ammunition
63	Mechanical Maintenance
67	Aircraft Maintenance
71	Administration
74	Information Systems Operations
77	Petroleum and Water

Table C.1 Career Management Field Description (CMF 11 through 77)

CAREER MANAGEMENT FIELD	DESCRIPTION
79	Recruiting and Retention
81	Topographical Engineering
88	Transportation
91	Medical
92	Supply and Services
93	Aviation Operations
95	Military Police
96	Military Intelligence
97	Bands
98	Signals Intelligence/Electronic Warfare Operations

Table C.2 Career Management Field Description (CMF 79 through 98)

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